REMEDIAL PLANNING ACTIVITIES AT SELECTED UNCONTROLLED HAZARDOUS SUBSTANCES DISPOSAL SITES FOR EPA REGION IV

U.S. EPA CONTRACT NO. 68-W9-0056

WORK ASSIGNMENT NO. 87-4CORO

FINAL

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY REPORT

ROSS METALS SITE
ROSSVILLE, TENNESSEE

VOLUME I
DOCUMENT CONTROL NO. 7740-087-RI-BTNW

November 11, 1998

Prepared for:
U.S. ENVIRONMENTAL PROTECTION AGENCY

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ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirements
B&V	Black and Veatch
bgs	Below ground surface
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminants of concern
CWA	Clean Water Act
CY	Cubic yard
EE/CA	Engineering Evaluation and Cost Analysis
EP	Extraction procedure
EPA	U.S. Environmental Protection Agency
ESD	Environmental Services Division
ERRB	Emergency Response and Removal Branch
FEMA	Federal Emergency Management Agency
FS	Feasibility study
gpm	Gallons per minute
HAP	Hazardous air pollutant
HELP	Hydrologic Evaluation of the Landfill Performance
MCL	Maximum contaminant level
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NGVD	National Geodetic Vertical Datum
NWI	National Wetlands Inventory
NPDES	National Pollutant Discharge Elimination System
NTU	Nephlometric Turbidity Units
Ogden	Ogden Environmental and Energy Services Company
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated biphenyl
ppm	Parts per million
PRC	PRC Environmental Management, Inc.
PRG	Preliminary remediation goal
PRSC	Post-removal site control
RCRA	Resource Conservation and Recovery Act
RA	Risk assessment
RI/FS	Remedial investigation/feasibility study
RM	Ross Metals
SPLP	Synthetic Precipitation Leaching Procedure
SRE	Streamlined Risk Evaluation
SVOC	Semivolatile organic compounds
SWPD	Solid Waste Processing and Disposal
SY	Square yard

TAPCR	Tennessee Air Pollution Control Regulations
TAQA	Tennessee Air Quality Act
TAT	Technical Assistance Team
TBC	To be considered
TCA	Tennessee Code Annotated
TCLP	Toxicity Characteristic Leaching Procedure
TDHE	Tennessee Department of Health and Environement
TSWQS	Tennessee Surface Water Quality Standards
TWQCA	Tennessee Water Quality Control Act of 1977
*u*g/L	Micrograms per liter
USC	United States Code
USGS	United States Geological Survey
WHPA	Well Head Protection Area
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

The Ross Metals Site (herein after referred to as "the RM site" or "the site") operated as a secondary lead smelter from 1978 to 1992, during which time the facility processed spent lead-acid batteries, lead dross, lead scrap, and other lead bearing material into reusable lead alloy. The site is located in a rural, residential area of Rossville, Fayette County, Tennessee. The site includes the process area, an unlined landfill containing about 10,000 cubic yards (CY) of blast slag located north of the process area, as well as contaminated wetlands located north and east of the process area and landfill. In addition, about 6,000 CY of stockpiled slag is stored on site in several deteriorating buildings. Lead-contaminated surface soil is located throughout the site, and lead-contaminated subsurface soil is present in isolated portions of the site.

The U.S. Environmental Protection Agency (EPA) developed an Engineering Evaluation/Cost Analysis (EE/CA) for the site based on data from previous investigations, including investigations conducted by EPA Region 4 in November 1996 and May 1997. One of the objectives of the EE/CA was to provide a framework for evaluating and selecting alternative technologies that could be used in developing a non-time critical removal action for the site. However, the EE/CA focused only on the process area and landfill. The contaminated wetlands north and east of these areas were not considered. In considering the information presented in the EE/CA and the statutory limits which apply to non-time critical removal actions, EPA determined that a remedial investigation /feasibility study (RI/FS) report that develops appropriate remedial action alternatives was needed for the site.

In April 1998, CDM Federal Programs Corporation (CDM Federal) was tasked by EPA to develop an RI/FS Report for the site by using the information provided in the EE/CA and other site reports under Contract No. 68-W9-0056. The purpose of this RI/FS is to document the nature and extent of contamination at the RM site and to develop and evaluate remedial alternatives, as appropriate.

Results of previous investigations that were used to develop this RI/FS show that lead-contaminated surface soil is present across the site. Lead concentrations in most surface soil and sediment samples collected throughout the site exceeded 400 ppm. In addition, aluminum, antimony, arsenic, barium, cadmium, copper, iron, manganese, selenium, and vanadium were detected above risk-based remedial goal option (RGO) levels. In addition, high levels of subsurface soil contamination were found in two isolated locations in the process area; east of the wrecker building, and southeast of the truck wash.

Analytical results of groundwater samples revealed the presence of several inorganic compounds at concentrations that either exceed the primary or secondary drinking water standards or the State of Tennessee domestic water supply criteria. Aluminum, arsenic, barium, cadmium, chromium, iron, lead, manganese, nickel and vanadium were detected above respective guidance concentrations and/or RGO levels. Analytical results of surface water samples revealed concentrations of several inorganic compounds that exceeded background concentrations. Significant inorganic contaminants included antimony, arsenic, cadmium, iron, lead, and manganese.

As a result of the baseline risk assessment (BRA) completed for the RI, COCs were defined for soil and groundwater. For the protection of human health, aluminum, antimony, arsenic, barium, cadmium, copper, iron, lead, manganese, selenium, and vanadium were defined as soil COCs. Groundwater COCs include aluminum, arsenic, barium, cadmium, chromium, iron, lead, manganese, nickel, and vanadium.

The ecological risk assessment conducted for the RM site identified wetlands north and east of the facility, as well as the facility itself, as areas of concern and evaluated the degree of contamination in wetlands farther from the facility that had not been previously evaluated. The ecological risk assessment concluded that of the metals calculated to pose a potential risk, lead posed the highest risk to the ecological risk receptors at the site.

Results from previous investigations suggest that lead will be the "driver" in any remediation effort conducted at the site. The presence of lead is sufficiently widespread that gearing a remediation effort to lead will also remediate other COC contamination, meaning that the extent of lead contamination serves as a good indicator of the extent of all the COC contamination at the RM site.

The primary objectives of the FS completed for the RM site were to support the identification of remediation goals for the media that have been identified as contaminated, to determine the extent of contamination above the remediation goals, to develop general response actions (GRAs), to identify, screen, and select remedial technologies and process options applicable to the contamination associated with the RM site, and to develop and analyze possible remedial action alternatives for the site.

Using the volumes of contaminated media calculated for the EE/CA and wetlands restoration, GRAs were identified. The most appropriate technologies applicable to the contamination at the site were chosen for each of the GRAs. Specific process options were then selected to represent those technologies. Remedial action alternatives were formulated considering the extent of contamination, contaminant type, contaminant concentrations, and applicable technologies. Six surface soil alternatives, three wetland sediment alternatives and three groundwater alternatives underwent a detailed evaluation on the basis of overall protection of human health and the environment, long-term effectiveness, compliance with ARARs, reduction of mobility, toxicity, and volume (M/T/V) through treatment, short-term effectiveness, implementability, and cost. A summary of this evaluation is presented in **Tables ES-1 through ES-3**.

The developed alternatives give decision makers a range of potential actions that could be taken to remediate this site. Actions for surface soil include:

- Alternative 1 No Action
- Alternative 2 Capping
- Alternative 3 Capping with Pavement in Place

Table ES-1

Summary of Soil Alternatives Evaluation
Ross Metals Site
Rossville, Tennessee

Remedial Alternative	Threshold Criteria		Balancing Criteria					
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability		Cost Approx. Total Present Worth
						Technical/Engineering Considerations	Estimated Time for Implementation (years)	
1 -- No Action	Does not eliminate exposure pathways or reduce the level of risk. Does not limit migration of or remove contaminants.	Chemical-specific ARARs are not met. Location- and action-specific ARARs do not apply.	The contaminated material is a long-term impact. The remediation goals are not met.	No reduction of M/T/V is realized.	Level D protective equipment is required during sampling.	None	<1	$100,247
2 -- Capping	Eliminates exposure pathways and reduces the level of risk. Isolates contamination and minimizes further migration.	All action-specific ARARs are expected to be met. Location-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with surface soil and sediment are greatly reduced. No residual risks from the alternative. Long -term effectiveness requires cap maintenance	Reduction of mobility is realized but contaminant volume or toxicity are not reduced. For the principal threat waste at the site, does not meet EPA's expectation to treat principal threat waste.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain.	<1	Opt.1-$1,735,804 Opt.2-$1,712,412
3 -- Capping With Pavement In Place	Eliminates exposure pathways and reduces the level of risk. Isolates contamination and minimizes further migration.	All action-specific ARARs are expected to be met. Location-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with surface soil and sediment are greatly reduced. No residual risks from the alternative. Long -term effectiveness requires cap maintenance	Reduction of mobility is realized but contaminant volume or toxicity are not reduced. For the principal threat waste at the site, does not meet EPA's expectation to treat principal threat waste.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain.	<1	Opt.1-$1,453,803 Opt.2-$1,430,411
4 -- Capping With Construction of Above-Ground Disposal Cell	Eliminates exposure pathways and reduces the level of risk. Isolates contamination and minimizes further migration.	All action-specific ARARs are expected to be met. Location-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with surface soil and sediment are greatly reduced. No residual risks from the alternative. Long -term effectiveness requires cap maintenance	Reduction of mobility is realized but contaminant volume or toxicity are not reduced. For the principal threat waste at the site, does not meet EPA's expectation to treat principal threat waste.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain.	<1	Opt.1-$1,506,847 Opt.2-$1,481,865

Note: Option 1 - volumes include excavated wetland sediment; Option 2 - wetland sediment not included in volumes

Table ES-1(cont)

Remedial Alternative	Threshold Criteria		Balancing Criteria					
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability		Cost Approx. Total Present Worth
						Technical/Engineering Considerations	Estimated Time for Implementation (years)	
5A -- Excavation and Onsite Treatment With Solidification/ Stabilization and Onsite Disposal	Eliminates exposure pathways and reduces the level of risk. Immobilizes contamination and eliminates further migration.	Chemical-specific ARARs are met. Location- and action-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with surface soil and sediment are eliminated. No residual risks from the alternative. Requires effective cap maintenance.	Mobility and toxicity are reduced, however, treatment process will increase volume. Meets EPA expectation to treat principal threat waste, but also treats (rather than contains) low-level threat wastes.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain.	<1	Opt.1- $4,907,274 Opt.2-$4,244,992
5B -- Excavation and Onsite Treatment With Solidification/ Stabilization and Offsite Disposal	Eliminates exposure pathways and greatly reduces the level of risk. Removes contamination and mitigates further migration.	ARARs are met through onsite treatment and offsite disposal.	Long-term public health threats associated with surface soil and sediment are eliminated. No residual risks from the alternative.	Mobility and toxicity are reduced, however, treatment process will increase volume. Meets EPA expectation to treat principal threat waste, but also treats (rather than contains) low-level threat wastes.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	None.	<1	Opt.1-$7,477,199 Opt.2-$6,181,160
6A -- Capping With Excavation and Onsite Treatment And Disposal Of Principal-Threat Waste	Eliminates exposure pathways and greatly reduces the level of risk. Removes contamination and mitigates further migration.	Chemical-specific ARARs are met. Location- and action-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with surface soil and sediment are eliminated. No residual risks from the alternative. Requires effective cap maintenance.	Mobility and toxicity are reduced, however, treatment process will increase volume. Meets EPA expectation to treat principal-threat waste and contain low-level threat waste.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain.	<1	Opt.1-$3,175,137 Opt.2-$2,729,543
6B -- Capping With Excavation and Onsite Treatment And Offsite Disposal Of Treated Principal-Threat Waste	Eliminates exposure pathways and greatly reduces the level of risk. Removes contamination and mitigates further migration.	Chemical-specific ARARs are met. Location- and action-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with surface soil and sediment are eliminated. No residual risks from the alternative. Requires effective cap maintenance.	Mobility and toxicity are reduced, however, treatment process will increase volume. Meets EPA expectation to treat principal-threat waste and contain low-level threat waste.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain	<1	Opt.1-$4,936,044 Opt.2-$4,013,508

Note: Option 1 - volumes include excavated wetland sediment; Option 2 - wetland sediment not included in volumes

Table ES-2

Summary of Wetland Sediment Alternatives Evaluation
Ross Metals Site
Rossville, Tennessee

Remedial Alternative	Threshold Criteria		Balancing Criteria					
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability		Cost Approx. Total Present Worth
						Technical/Engineering Considerations	Estimated Time for Implementation (years)	
1 -- No Action	Does not eliminate exposure pathways or reduce the level of risk. Does not limit migration of or remove contaminants.	Chemical-specific ARARs are not met. Location- and action-specific ARARs do not apply.	The contaminated material is a long-term impact. The remediation goals are not met.	No reduction of M/T/V is realized.	Level D protective equipment is required during sampling.	None	<1	$100,247
2 -- Capping w/Clean Fill and Off-site Creation of Wetlands	Potentially eliminates multipleexposure pathways to ecological receptors. Organisms utilizing portions of the wetlands below the surface may potentially continue to be exposed.	Does not meet ARARS for protection of wetlands.	Will reduce or eliminate viable exposure pathways and prevent degradation of adjacent wetlands No residual risks from the alternative. Long -term effectiveness requires cap maintenance	Reduction of mobility is realized but contaminant volume or toxicity are not reduced. For the principal threat waste at the site, does not meet EPA's expectation to treat principal threat waste.	Level C and D protective equipment required during site activities. Grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain and wetlands.	<1	$611,762
3 A -- Excavation and Revegetation/ Restoration of Wetlands and Regrading with Clean Fill	Eliminates exposure pathways and reduces the level of risk. Removes contamination and restores functional value of contaminated wetlands.	All action-specific ARARs are expected to be met. Location-specific ARARs are applicable and would need to be met.	Long-term ecological threats associated with sediment are greatly reduced. No residual risks from the alternative. Long -term effectiveness requires cap maintenance	Reduction of mobility, toxicity,and volume is achieved through removal, not treatment.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Short-term impacts to the wetlands from excavating activities will occur.	None.	<1	$780,071
3 B -- Excavation and Revegetation/ Restoration of Wetlands and Regrading with Biosolid Compost	Eliminates exposure pathways and reduces the level of risk. Removes contamination and restores functional value of contaminated wetlands.	All action-specific ARARs are expected to be met. Location-specific ARARs are applicable and would need to be met.	Long-term ecological threats associated with sediment are greatly reduced. No residual risks from the alternative. Long -term effectiveness requires cap maintenance	Reduction of mobility, toxicity,and volume is achieved through removal, not treatment. Additionally, use of biosolid compost reduces toxicity by limiting bioavailability of contaminants.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Short-term impacts to the wetlands from excavating activities will occur.	None.	<1	$699,548

Table ES-3
Summary of Groundwater Alternatives Evaluation
Ross Metals Site
Rossville, Tennessee

Remedial Alternative	Threshold Criteria		Balancing Criteria					
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability		Cost Approx. Total Present Worth
						Technical/Engineering Considerations	Estimated Time for Implementation (years)	
1 -- No Action	Does not eliminate exposure pathways or reduce the level of risk. Does not limit migration of or remove contaminants.	Chemical-specific ARARs are not met. Location- and action-specific ARARs do not apply.	The contaminated groundwater is a long-term impact. The remediation goals and MCLs are not met.	No reduction of M/T/V is realized.	Level D protective equipment is required during sampling.	None	<1	$86,597
2 -- Limited Action	Unless contingency component is implemented, does not eliminate exposure pathways. Minimally reduces the level of risk.	Chemical-specific ARARs are not met. Location- and action-specific ARARs do not apply unless contingency component is implemented.	The contaminated groundwater is a long-term impact. The remediation goals and MCLs are not met.	No reduction of M/T/V is realized, unless contingency component is implemented.	Level D protective equipment is required during sampling.	Additional data collection needed to determine aquifer characteristics and vertical extent of contamination. Treatability study may be needed to develop contingency treatment component.	<1	$498,095
3 -- Pump & Treat With Physical and/or Chemical Treatment	Eliminates exposure pathways and reduces the level of risk. Reduces contamination and eliminates further migration.	Chemical-specific ARARs are met. Location- and action-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with groundwater are eliminated. No residual risks from the alternative.	Mobility ,toxicity and volume are reduced.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Additional data collection required to determine aquifer characteristics and vertical extent of contamination. Treatability study may be needed to define treatment component.	5-12	A -- $1,359,116 B -- S1,185,719 C -- $867,484 D -- $1,652,450

- Alternative 4 Capping with Construction of Above-Ground Disposal Cell
- Alternative 5 A/B Excavation and Onsite Treatment with Solidification/Stabilization
- Alternative 6 A/B Capping with Excavation and Onsite Treatment of Principal Threat Waste

Actions for wetland sediment include:

- Alternative 1 No Action
- Alternative 2 Capping with Clean Fill and Off-site Creation of Wetlands
- Alternative 3 A/B Excavation and Revegetation/Restoration of Wetlands

Actions for groundwater include:

- Alternative 1 No Action
- Alternative 2 Limited Action
- Alternative 3 A/B/C/D Pump & Treat With Physical and/or Chemical Treatment

Finally, **Tables ES-4 through ES-6** present a summary of each remedial alternative along with ranking scores for each evaluation criterion. Each alternative's performance against the criteria (except for present worth) was ranked on a scale of 0 to 5, with 0 indicating that none of the criterion's requirements were met and 5 indicating all of the requirements were met. The ranking scores are not intended to be quantitative or additive, rather they are only summary indicators of each alternative's performance against the CERCLA evaluation criteria. The ranking scores combined with the present worth costs provide the basis for comparison among alternatives.

Table E-4

Comparative Analysis of Soil Alternatives
Ross Metals Site
Rossville, Tennessee

Remedial Alternative	Criteria Rating [1]						Approximate Present Worth ($)
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability	
1 -- No Action	0	0	0	0	5	5	$100,247
2 -- Capping	4	4	2	3	4	3	Opt.1-$1,735,804 Opt.2-$1,712,412
3 -- Capping With Pavement In Place	4	4	3	3	4	3	Opt.1-$1,453,803 Opt.2-$1,430,411
4 -- Capping With Constuction of Above-Ground Disposal Cell	4	4	3	3	4	3	Opt.1-$1,506,847 Opt.2-$1,481,865
5A -- Excavation and Onsite Treatment With S/ S and onsite Disposal	5	4	4	5	4	3	Opt.1-$4,907,274 Opt.2-$4,244,992
5B -- Excavation and Onsite Treatment With S/S and offsite Disposal	5	5	5	5	4	4	Opt.1-$7,477,199 Opt.2-$6,181,160
6A -- Capping With Excavation & Onsite Treatment/Disposal of Principal Threat Waste	5	4	4	5	4	3	Opt.1-$3,175,137 Opt.2-$2,729,543
6B -- Capping With Excavation & Onsite Treatment and Offsite Disposal of Principal Threat Waste	5	4	4	5	4	3	Opt.1-$4,936,044 Opt.2-$4,013,508

[1]A ranking of “0" indicates noncompliance, while a ranking of “5" indicates complete compliance.
Note: Option 1 - volumes include excavated wetland sediment; Option 2 - wetland sediment not included in volumes

Table E-5

Comparative Analysis of Wetland Sediment Alternatives
Ross Metals Site
Rossville, Tennessee

Remedial Alternative	**Criteria Rating [1]**						**Approximate Present Worth ($)**
	Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of M/T/V Through Treatment**	**Short-Term Effectivenes s**	**Implementabilit y**	
1 -- No Action	0	0	0	0	5	5	$100,247
2 -- Capping with Off-site Creation of Wetlands	3	2	2	3	3	4	$611,762
3 A -- Excavation, Regrading with Clean Fill and Wetlands Revegetation/ Restoration	5	5	5	4	4	4	$780,071
3 B -- Excavation, Regrading with Biosolid Compost Material and Wetlands Revegetation/ Restoration	5	5	5	5	4	3	$699,548

[1]A ranking of “0" indicates noncompliance, while a ranking of “5" indicates complete compliance.

Table E-6

Comparative Analysis of Groundwater Alternatives
Ross Metals Site
Rossville, Tennessee

Remedial Alternative	Criteria Rating [1]						Approximate Present Worth ($)
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectivenes s	Implementabilit y	
1 -- No Action	0	0	0	0	5	5	$86,597
2 -- Limited Action	1	0	0	0	5	5	$498,095
3 A/B /C/D-- Pump & Treat w/ Physical/Chemical Treatment	5	5	5	5	4	4	A-$1,359,116 B-$1,185,719 C- $867,487 D-$1,652,450

[1]A ranking of “0" indicates noncompliance, while a ranking of “5" indicates complete compliance.
Note: Scenarios A,B,C, and D of Alternative 3 represent different system designs ranging from 1 to 15 extraction wells.

Note that the rankings for Groundwater Alternative 3 are based on the results of the original Random-Walk Modeling completed as part of the EE/CA for the RM site. The selection of a specific pump and treat alternative would be based on the outcome of treatability testing and additional modeling to better define aquifer and plume properties, and ensure technical practicability.

1.0 INTRODUCTION

The Ross Metals Site (herein after referred to as "the RM site" or "the site") operated as a secondary lead smelter from 1978 to 1992, during which time the facility processed spent lead-acid batteries, lead dross, lead scrap, and other lead bearing material into reusable lead alloy. The site is located in a rural, residential area of Rossville, Fayette County, Tennessee. The site includes the process area, an unlined landfill containing about 10,000 cubic yards (CY) of blast slag located north of the process area, as well as contaminated wetlands located north and east of the process area and landfill. In addition, about 6,000 CY of stockpiled slag is stored on site in several deteriorating buildings. Lead-contaminated surface soil is located throughout the site, and lead-contaminated subsurface soil is present in isolated portions of the site.

The U.S. Environmental Protection Agency (EPA) developed an Engineering Evaluation/Cost Analysis (EE/CA) for the site based on data from previous investigations, including investigations conducted by EPA Region 4 in November 1996 and May 1997. One of the objectives of the EE/CA was to provide a framework for evaluating and selecting alternative technologies that could be used in developing a non-time critical removal action for the site. However, the EE/CA focused only on the process area and landfill. The contaminated wetlands north and east of these areas were not considered. In considering the information presented in the EE/CA and the statutory limits which apply to non-time critical removal actions, EPA determined that a remedial investigation /feasibility study (RI/FS) report that develops appropriate remedial action alternatives was needed for the site.

In April 1998, CDM Federal Programs Corporation (CDM Federal) was tasked by EPA to develop an RI/FS Report for the site by using the information provided in the EE/CA and other site reports under Contract No. 68-W9-0056. The purpose of this RI/FS is to document the nature and extent of contamination at the RM site and to develop and evaluate remedial alternatives, as appropriate.

The RI portion of this report presents analytical results from samples collected at and near the site, evaluates those results to determine the nature and extent of contamination, and assesses resulting risk to human health and ecological receptors. The primary objectives of the FS portion of the report are to: identify remediation goals; determine the extent of contamination above remediation goals; present remedial action objectives (RAOs) for contamination; develop general response action (GRAs); identify, screen, and select remedial technologies and process options applicable to the contamination associated with the site; and develop and analyze remedial action alternatives. The RI/FS report will be used to support subsequent decision documents, and the design and implementation of remedial actions for the contamination attributable to the RM site.

It should be noted that the analytical data used to determine the nature and extent of contamination at the RM site was collected during previous investigations at the site. No additional data were collected under this work assignment. In addition, the baseline risk assessment developed for the RI/FS includes a summary of an ecological risk assessment completed by EPA.

This RI/FS report has been prepared in accordance with EPA's document entitled , "Guidance for Conducting Remedial Investigations and feasibility Studies Under CERCLA, Interim Final" (USEPA 1988). This report thus provides the basis for remedy selection by EPA and the State of Tennessee for the RM site, as well as the design and implementation of remedial actions at the site. This RI/FS report consists of twelve sections. Brief summaries of the remaining sections are presented below:

- Section 2.0 briefly summarizes data and information with regard to the physical setting and past operations at the RM site.

- Section 3.0 summarizes the previous investigations conducted at the site which provide the analytical data on which this report is based.

- Section 4.0 details nature and extent of contamination at the RM site by presenting the results from the previous investigations.

- Section 5.0 presents the baseline risk assessment regarding contamination attributable to the RM site. A summary of the ecological risk assessment completed by EPA also is included.

- Section 6.0 summarizes contaminant fate and transport applicable to RM site contamination.

- Section 7.0 presents conclusions regarding nature and extent of RM site-related contamination.

- Section 8.0 discusses federal and state applicable or relevant and appropriate requirements (ARARs) and the objectives of remedial action at the site. The objectives are developed to address the risks posed to human health and the environment by the contamination found at the site. This section also discusses the remediation goals for the media of concern, as well as the extent of contamination exceeding those goals.

- Section 9.0 identifies GRAs that will satisfy the cleanup objectives. A wide range of technologies and process options that are applicable to the response actions and site characteristics are then identified and screened before assembly of remedial action alternatives. The screening process focuses on eliminating those technologies and process options that have severe limitations for a given set of waste- and site-specific conditions, as well as inherent technology limitations.

- Section 10.0 discusses the formulation of remedial action alternatives which is the combination of GRAs and process options chosen to represent the various technology types for each medium of concern. A range of alternatives was assembled that results in differing levels of site cleanup. These alternatives were developed and described in detail to facilitate subsequent screening. The alternatives were then evaluated to determine their overall effectiveness, implementability, and cost. Alternatives with the most favorable overall evaluations were retained to undergo detailed analysis.

- Section 11.0 presents a detailed analysis of the remedial action alternatives that passed the screening process in Section 10.0. This analysis was performed to provide the necessary information for EPA and the State of Tennessee to select a remedial action for implementation. The evaluation was based on a group of technical, environmental, human health, and institutional criteria. Cost estimates also were developed for each alternative.

- Section 12.0 compares and summarizes the effectiveness of each remedial action alternative analyzed.

2.0 SITE BACKGROUND

This section provides background information on the RM site, including physical setting and operational history.

2.1 SITE CHARACTERIZATION

2.1.1 SITE LOCATION AND DESCRIPTION

The RM facility is located at 100 North Railroad Street in Rossville, Fayette County, Tennessee, (see **Figure 2-1**). The facility's geographic coordinates are 35º 02' 57" North latitude and 89º 32' 55" West longitude, as shown on the U.S. Geological Survey (USGS) topographic map quadrangle for Rossville, Tennessee (U.S. Geological Survey [USGS] 1965). The site includes contaminated wetlands to the north and northeast of the process area and the landfill. It is bordered by residential property to the east, the Southern Railroad tracks to the south, and a municipal wastewater treatment plant to the west. A site layout is presented in **Figure 2-2**.

2.2.2 OPERATIONAL HISTORY

From 1978 until June 20, 1992, RM operated a secondary lead smelter at the site. Prior to 1978, the property was undeveloped. RM produced specification alloyed lead that was sold for use in manufacturing vehicle batteries, lead shot pellets, and sheet lead (radiation shields) (Ogden Environmental Energy Services Company [Ogden] 1994). The facility received spent lead acid batteries, spent lead plates, lead oxide, scrap metal, and other lead waste and material from various businesses and industries, including battery crackers and battery manufacturers. The primary material used for the recycling process was spent lead acid batteries, with automotive and industrial batteries accounting for 80 percent of the raw material processed. The remaining 20 percent consisted of other lead-bearing materials, such as recycled dross, dust slag, and factory scrap. Facility operations included not only the smelting of lead and other scrap metals

Fig 2-1

Fig 2-2

but a variety of other products, such as crushed drums, limestone, steel, and cast iron. These materials were added to the blast furnace as flux to create a reducing atmosphere. Wastes generated from the process included slag, plastic chips, waste acid, lead emission control dusts, and lead-contaminated stormwater (Black & Veach Waste Science, Inc. [B&V] 1996).

Upon receipt, batteries were stored on pallets located east and southeast of the facility; each pallet held about 50 batteries. The batteries were then conveyed to the wrecker building for the battery breaking operation. Wastewater used for battery breaking operations conducted inside the wrecker building was contained and managed by an on-site wastewater treatment system. Water was used to separate lead from other battery components based on its density. After separation, lead was transported to the blast furnace slag area, where lead materials were passed through a smelter. According to facility representatives, 99 to 99.5 percent of the lead content was recovered. The molten lead product was then moved to the refinery area. The refinery area consisted of four kettles that received molten lead and formed ingots. The ingots were then moved to the finished storage area until they were shipped to customers (B&V 1996).

Acid and sludge obtained during the battery breaking operation contained residual amounts of lead and lead acid; the acid and sludge were transferred to the wastewater treatment unit to reclaim the remaining lead. Lead was reclaimed by allowing it to settle further in aboveground collection tanks. This lead sludge, collected prior to neutralization, was transferred to the blast furnace area and immediately fed into the furnace. The remaining acid was neutralized with liquid caustic soda. Upon neutralization, the solution was held for additional settling to precipitate dissolved metals. Sludge resulting from the neutralization process was also collected in settling tanks and recycled into the blast furnace with other lead scrap. The pH of the waste stream generated by the facility was further adjusted, and sludge-free effluent was discharged to the Rossville Municipal Sewage Treatment Facility (Tibbels 1983).

Several areas of the operating facility contained large volumes of lead-bearing materials. With the exception of the container storage area, the lead-bearing materials were not containerized; instead, they were placed on the asphalt foundation of the facility or directly on facility soils.

From 1979 until December 1988, blast slag that had accumulated as a part of the smelting process was disposed of in an on-site landfill. On November 3, 1986, RM submitted a petition for registration for an existing industrial landfill used to dispose of blast furnace slag; RM considered the slag a nonhazardous industrial waste. On November 8, 1988, RM submitted a RCRA Part B application stating that slag had been deposited on site. Diagrams included in the application show slag piles both inside and outside of the area designated as the landfill. On December 20, 1988, the Tennessee Department of Health and Environment (TDHE) suspended all further processing of the request until results from an EPA sampling event could be assessed and the EPA could determine whether the blast slag was a nonhazardous waste (B&V 1996). Several references in the EPA files for the RM site debate the status of blast slag as a hazardous waste. File material also indicates that on April 20, 1990, RM applied for a solid waste classification variance for the blast slag. The variance was denied on June 6, 1990, because EPA determined that blast slag was a hazardous waste and subject to the full extent of RCRA regulations.

About 10,000 CY of slag are landfilled in an unlined area located just north of the process area; the unlined landfill is located in what was previously a wetland. Wetland areas are still present to the north and northeast of the landfill. Groundwater and surface water in the immediate vicinity of the landfill have lead concentrations that exceed background. About 6,000 CY of stockpiled lead slag material are still stored at the facility inside deteriorating sheet metal buildings. Sample results of the stockpiled slag indicate that lead is the primary hazardous constituent in the material.

2.2 ENVIRONMENTAL SETTING

This section presents information on climate, physiography, surface water, geology and hydrogeology, and population and land use in the site vicinity.

2.2.1 CLIMATE

The RM site is located in southwest Tennessee, about 30 miles west of Memphis. This area has an average annual daily temperature of about 62.3 ^{o}F. The normal daily minimum and maximum temperatures are 52.4 ^{o}F and 72.1 ^{o}F, respectively. Annual precipitation is 52.10 inches. (Source: National Weather Service Historic Data for Memphis, 1961-1990).

2.2.2 PHYSIOGRAPHY

The RM site is located in the Gulf Coast Plain Physiographic Province of western Tennessee, which is characterized by unconsolidated near-surface sands, silts, and clays. Elevations within the surrounding area vary from 290 to 470 feet National Geodetic Vertical Datum (USGS 1965). Ground elevations within the site boundaries range from about 315 NGVD near the main office building to about 310 NGVD at the northeast corner of the fenced portion of the site. The RM site is located about 0.5 miles south of the Wolf River.

The RM site consists of an old fenced facility area enclosing about 5.5 acres and a blast slag landfill covering about 2.5 acres north of the old fenced area, and contaminated wetlands located north and east of the facility and landfill areas. The fenced area includes several buildings, most of which are constructed of sheet metal. Most of the area inside the fence is paved with either concrete or asphalt, and concrete curb is located just inside the fence. The curb was apparently constructed to divert storm water runoff to the storm water collection sump in the northeast corner of the property. Several stockpiles of waste slag are located in various buildings, including the wrecker building, the slag fixation container, the furnace raw materials refinery building, and the shipment building. The buildings are generally in poor condition, and some are in danger of collapsing.

The landfill area was constructed in a wetland area north of the fenced area. Several soil-covered mounds ranging up to 6 feet high are located in the landfill area. An 8-inch-thick concrete slab is located just north of the gate in the landfill area; however, evidence suggests that some slag may be buried beneath the concrete slab. An estimated 10,000 CY of slag is buried throughout the landfill at thicknesses of up to about 4 feet. About 1 to 2 feet of fill material has been placed over the slag throughout the landfill.

As indicated on **Figure 2-3**, the RM facility and the wetlands north and east of the facility are located in a 100-year floodplain. **Figure 2-4** illustrates the type of wetlands that are part of the RM site.

2.2.3 SURFACE WATER

Storm water runoff from the entire facility drains into a basin located at the northeastern corner of the fenced facility. The basin discharged to a small wetland area located north and northeast of the facility area. During an inspection on October 14, 1993, the holding dike of the storm water basin was observed to be overflowing, and storm water was apparently not being collected in on-site storage tanks for wastewater treatment. Runoff from the landfill also drained to the wetland located north and northeast of the landfill; in addition, the landfill has no documented run-on, run-off, or collection facilities. The landfill is documented to lie adjacent to a wetland area; however, the wetlands are not delineated on the National Wetland Inventory (NWI) map. Due to its small size (3 to 5 acres), the wetland was determined to be too small for delineation on typical NWI maps.

The wetlands and wooded area extend to the north and ultimately drain to the Wolf River, which

Figure 2-3

Figure 2-4

is the main drainage body for the region. The Wolf River flows west, through Memphis, and into the Mississippi River.

The Rossville municipal wastewater treatment plant is located west of the RM site. The outfall for the treatment plant is located on the Wolf River at the Highway 194 bridge, about 1.5 miles upstream of the facility. The outfall and the treatment plant are not expected to have any adverse effect on the wetland located north and northeast of the site.

2.2.4 GEOLOGY AND HYDROGEOLOGY

The site is located in the Gulf Coast Plain Physiographic Province of Western Tennessee, which is characterized by unconsolidated near-surface sands, silts, and clays. Included in this sequence of unconsolidated sediments is the Memphis Sand, which contains an important water-bearing zone known as the Memphis aquifer. The Memphis Sand consists of a thick body of sand that contains clay and silt lenses or beds at various horizons. The sand ranges from very fine to very coarse (B&V 1996). A regional cross-section is provided as **Figure 2-5**.

Recharge of the Memphis aquifer generally occurs along the outcrop of the Memphis Sand. Recharge results from precipitation and from downward infiltration of water from the overlying fluvial deposits and alluvium, where present. In the outcrop-recharge belt, the Memphis aquifer is under water-table conditions (unconfined), and the configuration of the potentiometric surface is complex and generally conforms to the topography. West of the outcrop-recharge belt, the aquifer is confined by other members of the Claiborne Group containing clay, silt, sand, and lignite. Groundwater in the unconfined portion of the Memphis aquifer typically flows to the west. Transmissivities of the Memphis aquifer in the Memphis area range from about 20,000 to 42,800 square feet per day. However, USGS literature referenced only one test conducted in Fayette County (the location of the RM facility); the test indicated a transmissivity of 2,700 square feet per day. (B&V 1996).

Fig 2-5

The RM facility was constructed in a wetland; RM reportedly spread and compacted several feet of clay prior to constructing the facility. A 1987 memorandum written by the State of Tennessee indicates that clayey silt was present in the area of the industrial landfill before its construction; the clayey silt was present from 0 to 3 feet, and a silty clay was present from about 3 to 7 feet.

In May 1988, five monitoring wells were installed by RM's contractor. The borings for the monitoring wells indicated the presence of about 11 feet of silty clay and clayey silt overlying sands of the Memphis sand aquifer. In May 1997, eight additional monitoring wells were installed at the site. A soil boring (T-4) was also drilled in the southwest corner of the site, but it was not completed as a monitoring well. Monitoring well depths ranged from 23 to 28 feet below ground surface (bgs).

Soil samples collected during soil boring activities revealed that site stratigraphy conformed generally to the May 1988 data collected by the RM contractor. The predominant soil type observed in surficial to shallow soil intervals (within 10 feet bgs) consists of gray, mottled, dry to moist clay. The clay unit contains a high percentage of silt (except in the western portion of the site, where it grades to sandy clay); exhibits low plasticity and variable organic content; and occasionally exhibits a brown to tan coloration. The clay unit extends from ground surface to depths ranging from 7 to 20 feet bgs and is generally thickest in the western portion of the site.

Sands encountered at the site are fine-grained and grayish-white in color. Sands are generally well sorted and exhibit a fine to medium texture with occasional clay lenses and very little silt. Sand textures generally coarsen with increasing depth, becoming medium to coarse in texture below 20 feet bgs. A trend toward a decrease in the degree of sorting and an increase in the coarse sand fraction was also observed in samples collected from below 20 feet bgs.

Groundwater at the site is encountered in the upper portion of the sand section. The aquifer possesses a degree of hydrologic confinement due to the pervasive upper clay section, and water levels in site monitoring wells rise above the base of the clay unit.

Information collected during the 1988 and 1997 investigations conducted by the RM contractor and PRC, respectively, conflict somewhat with a Tennessee memorandum written in 1987 concerning the actual depth of clay beneath the site. However, it can be assumed that at least 7 feet of silty clay and clayey silt are present directly under the site; it remains undetermined how much, if any, of it is native material. Some of the clay may be part of the base of the Cook Mountain Formation or a clay lens within the upper part of the Memphis Sand. Occurrences of the overlying members of the Claiborne Group in the area of the site may be thin or absent above the Memphis Sand. **Figures 2-6** and **2-7** present cross section information obtained from the EPA site investigations. Additional cross-sections were prepared for this RI/FS report using boring logs from monitor wells constructed in 1997. The 1997 boring cross-section locations are illustrated on **Figure 2-8**. The 1997 cross-sections are presented on **Figures 2-9** and **2-10**.

Although regional groundwater flows to the west, measurements collected from site monitoring wells in 1990 indicate that shallow groundwater movement is north towards the Wolf River. However, measurements collected from the monitoring wells in 1996 suggest a more northwesterly movement of groundwater. **Figures 2-11** and **2-12** present groundwater flow based on measurements collected in an October 1990 investigation, and November 1996 investigation, respectively. Two municipal supply wells and three industrial production wells are located within 0.75 mile of the site and are screened in the Memphis aquifer.

2.2.5 POPULATION AND LAND USE

The area surrounding the site is primarily rural or residential. A municipal wastewater treatment plant is located adjacent to the western site boundary, and no other known industries would have contributed contamination to the site. The towns of Rossville, Rossville Junction, and New Bethel are located within a 4-mile radius of the site; the total population within the 4-mile radius is 1,947. The nearest school is located 0.3 miles southwest of the site.

Fig2-6

Fig 2-7

Fig 2-8

fig 2-9

fig 2-10

fig 2-11

fig 2-12

3.0 SITE INVESTIGATIONS

3.1 PREVIOUS INVESTIGATIONS

EPA has conducted numerous sampling investigations at the RM site. A discussion of sample results from these investigations is presented in Section 4.1, and analytical results are tabulated in Appendix A.

In May and November 1990, EPA Region 4 Environmental Services Division (ESD) conducted RCRA investigations that included the collection of groundwater, surface water, surface soil, and slag samples.

From September 22 through December 29, 1994, the EPA Emergency Response and Removal Branch (ERRB) conducted an emergency time-critical removal of hazardous substances at the RM site. Source materials, structures, and debris were removed and disposed of off site. Approximately 4,400 gallons, 170 tons, and 1,700 CY of waste were removed. Groundwater and surface soil samples were also collected during this event.

During the week of June 13, 1995, the EPA Region 4 contractor, Black & Veatch (B&V), conducted a site investigation; groundwater, surface and subsurface soil, sediment, and surface water samples were collected.

In November 1996, EPA ESD conducted a remedial site characterization that included surface and subsurface soil, groundwater, surface water, and wipe samples from the buildings.

During the weeks of May 19 and May 26, 1997, EPA contracted PRC to conduct additional field sampling at the site. PRC completed the installation and sampling of nine monitoring wells, including borehole soil sampling. Two additional groundwater samples were collected from on-site temporary wells, and one groundwater sample was collected from a well at the wastewater treatment plant on adjacent property located west of the RM site. Soil samples from the landfill and a composite sample of slag stockpiles were also collected for analysis.

File material indicates that children living near the site have elevated levels of lead in their blood. Soil samples collected adjacent to nearby homes indicated 1,170 parts per million (ppm) of lead. However, the presence of lead-based paint in homes near the site has been documented. Although the documentation is not strong enough to establish an observed release, the findings are significant because of the proximity of adjacent residences and the history of slag burning at the RM site (B&V 1996).

In April 1997, EPA collected surface water, sediment, plant tissue, grasshopper, and frog tissue samples as part of the completion of an ecological risk assessment for the site. All the sediment samples were analyzed for arsenic, cadmium, copper, and lead via field portable x-ray fluorescence (XRF). In addition, several of the surface water and sediment samples collected for the ecological risk assessment were analyzed for TAL metals by an offsite laboratory. Samples from two of the surface water and sediment locations analyzed for TAL metals also were analyzed for volatile organic compounds (VOCs), base neutral acids (BNAs) and pesticide/PCBs. Surface water and sediment results are discussed in Section 4.0 and tabulated in Appendix A. The ecological investigation sample locations are illustrated on **Figure 3-1**. Sample locations for the other investigations along with sample results are illustrated in Section 4.0.

In December 1997, EPA/ERTC collected and performed on-site analysis of soil samples for metals contamination, to delineate contaminant levels in the wetlands. Additionally, the effort involved the completion of treatability studies to evaluate soil treatment, and the completion of a wetlands excavation and revegetation plan to provide a design for wetlands restoration. Target elements were arsenic, cadmium, lead, and zinc. A reference grid was established on the site and surface samples were collected at the grid nodes. The grid included the wetlands located north and east of the site. The results of 29% of the samples were confirmed by Inductively

Fig 3-1

Coupled Plasma (ICP) analysis. Sample locations are illustrated on **Figure 3-2**.

3.2 QUALITY ASSURANCE

Because this RI/FS relies on data collected from previous investigations conducted over several years, a full assessment of quality assurance (QA) procedures used in the collection of that data is difficult to complete. However, a brief review of data packages and previously generated reports indicates that most of the data was collected by EPA and sufficient QA/QC procedures were in use. The data should prove useable for the purpose of completing this RI/FS report.

fig 3-2

4.0 NATURE AND EXTENT OF CONTAMINATION

This section summarizes and evaluates results of previous sampling activities described in Section 3.0. Specifically, the following sections summarize the nature and extent of surface soil and sediment, subsurface soil, surface water, groundwater, waste slag, and building contamination from samples collected during previous sampling events. A condensed summary of sampling results is presented in Appendix A.1. In addition, sampling locations and results are illustrated on **Figures 4-1** through **4-5**.

4.1. SURFACE SOIL AND SEDIMENT

Pre-1997 Investigations

In May 1990, the EPA Region IV Science and Ecosystem Support Division (SESD) formerly Environmental Services Division (ESD) collected surface soil and sediment samples that consisted of three grab soil samples and one grab sediment sample; the samples were collected along the northern and eastern property boundaries. In November 1990, SESD collected three surface soil samples and one sediment sample along the northern and eastern property boundaries; two background samples were also collected. Samples from both 1990 events were analyzed for total metals. Selected samples were also analyzed for extraction procedure (EP) Toxicity metals, Toxicity Characteristic Leaching Procedure (TCLP) metals, and limited pesticide and polychlorinated biphenyls (PCB).

In 1994, ERRB collected surface soil grab samples from four locations east of the eastern property boundary, five from the landfill area, and one near the northeast corner of the landfill. Surface soil composite samples were collected at two locations in the landfill, one off-site location near both the eastern and western property boundaries, and two locations from the south and southwest portions of the old fenced area. In 1995, B&V collected one surface soil sample from the landfill area.

Fig. 4-1

fig 4-2

fig 4-3

fig 4-4

fig 4-5

In November 1996, SESD collected 59 surface soil samples from the site, including locations north and east of the old fenced area. For sample locations underneath the pavement, the pavement was cored, and a sample was obtained from the underlying soil.

Surface soil and sediment samples were collected at depths of up to 2 feet bgs. Lead concentrations in most surface soil and sediment samples collected throughout the site exceeded 400 ppm. Lead-contaminated surface soil is present across the site, and antimony, arsenic, and cadmium were detected in isolated areas throughout the site as well as in sample locations where lead concentrations exceeded 400 ppm. Figure 4-2 presents locations and lead concentrations of surface soil and sediment samples throughout the site.

<u>Ecological Risk Assessment Field Investigation</u>

In April 1997, the EPA Region Environmental Response Team Center (ERTC) collected sediment samples for chemical analysis from the wetlands north and east of the landfill and old fenced area as part of the completion of an ecological risk assessment. Sample locations are illustrated on Figure 4-5. Four sediment samples each were collected from Locations 2, 3, 12, 15, 26, and a reference area in an effort to determine the degree of bioaccumulation of metals from the sediment to the plants. TAL metals analyses results as well as analytical results from organic fractions are summarized in Appendix A.2. Additional samples were collected from a second reference area and the Wolf River. These results are presented in Appendix A.3. XRF data collected in support of the ecological risk assessment effort are presented in Table A.4

A review of the TAL metal data indicates that the mean concentrations of all the metals in the site samples exceeded the mean concentrations for the reference samples except for beryllium, cobalt, iron, magnesium, manganese, and vanadium. Comparisons of site versus reference area mean and maximum concentrations for lead and arsenic are notable. The reference area mean and maximum values for lead were 29.6 mg/kg and 54.9 mg/kg, respectively, while the mean and maximum values for lead for the site samples were 14,808 mg/kg and 98,100 mg/kg, respectively. Some of the highest metal concentrations were detected in samples collected from the sump area and location 3. The maximum lead concentration was detected in a sample collected from location 3, however, nearly all the samples collected from locations 2, 3, 12 and 15 had lead concentrations over 400 mg/kg. Lead concentrations in samples collected from the Wolf River and the additional reference location ranged from 9.9 mg/kg to 14.9 mg/kg.

The reference area mean and maximum values for arsenic were 5.58 and 8.10 mg/kg, while the mean and maximum concentrations of arsenic in the site samples were 92.1 mg/kg and 681 mg/kg, respectively. The maximum concentration for arsenic was detected in a sample collected from location 3. Arsenic concentrations in samples collected from the Wolf River and the additional reference location ranged from 3.2 mg/kg to 5.8 mg/kg.

Samples for volatile organic compound (VOC) analysis, base-neutral-, acid-extractable (BNA) analysis, and pesticide/PCB analysis were collected from locations 3 and 12. Thirteen VOCs were detected in the sample collected from location 12 including 1,2,4-trimethylbenzene at 190 ug/kg and p- and m-xylene at 230 ug/kg. Several BNA compounds were detected in the samples collected from both locations, however, only bis(2-ethylhexyl)phthalate was detected above the method quantitation limit at concentrations of 1,000 ug/kg at Location 3 and 2,400 ug/kg at Location 12. No pesticide or PCBs were detected in samples from either of the locations, although it should be noted that DDD, and DDT data were rejected during the validation process, meaning the presence of these compounds in these samples is unknown.

December 1997 Investigation

In December 1997, EPA ERTC collected soil samples for onsite XRF analysis for arsenic, cadmium, lead, and zinc. Samples were collected from a grid system established at the site which included the wetlands north and east of the site. With only five exceptions, lead was always detected above its mininum detection limit of 42 mg/kg. The highest levels of lead were found at locations E000 (14,000 mg/kg), E300 (29,000 mg/kg), E300-3 (53,000 mg/kg), E700 (14,000 mg/kg) and E700-4 (17,000 mg/kg). E300-3 and E700-4 were collected from 3 and 4 inches bgs respectively.

On the other hand, arsenic, with only three exceptions, was not detected above its minimum detection limit of 42 mg/kg. Arsenic was detected in sample E200 DUP (45J mg/kg), B400 (66J mg/kg), and C400 (77J mg/kg). Sample results are presented in Appendix A.4. Refer to Figure 3-2 for sample locations.

4.2 SUBSURFACE SOIL

Subsurface soil samples were collected in the B&V 1995, the SESD 1996, and the PRC 1997 sampling events. One sample was collected during the 1995 sampling event in the landfill area. Subsurface sample locations in the 1996 investigation corresponded with those performed concurrently for old fenced area surface sample locations (with the exception of 021 SLB, located adjacent to the wrecker building); additional samples were collected at depths just above and beneath the landfilled slag. For the 1997 sampling event, samples were collected from five soil borings installed on and off site; composite split-spoon samples were collected at 2-ft intervals at depths from 0 to 10 feet bgs. In addition, two locations at the landfill were sampled at depths just above and beneath the landfilled slag. All samples were analyzed for total metals. Synthetic Precipitation Leaching Procedure (SPLP) analysis was conducted on selected samples.

Lead concentrations in subsurface soil samples exceeded 400 parts per million (ppm) in the following isolated locations throughout the site: the landfill, east of the wrecker building, and southeast of the truck wash. Subsurface soil samples exhibiting elevated lead concentrations were collected at depths ranging from 18 to 40 inches beneath the pavement near the wrecker building and the truck wash and at depths of up to 5.5 feet in the landfill. Subsurface soil samples were collected both above and beneath the landfilled slag material; however, none of the soil samples collected from beneath the buried slag exhibited lead concentrations in excess of 400 ppm.

4.3 SURFACE WATER

Pre-1997 Investigations

One surface water sample was collected from each of the two 1990 sampling events conducted by SESD, five surface water samples and one background sample were collected during the 1995 sampling event, and one surface water sample was collected during the 1996 SESD sampling event. Samples were analyzed for total metals.

Analytical results of surface water samples revealed concentrations of several inorganic compounds that exceeded background concentrations. Significant inorganic contaminants included antimony, arsenic, cadmium, iron, lead, and manganese. Surface water sample results are presented on Figure 4-3.

Ecological Risk Assessment Field Investigation

In April 1997, the EPA Region Environmental Response Team Center (ERTC) collected sediment and surface water samples for chemical analysis from the wetlands north of the site as part of the completion of an ecological risk assessment. Sample locations are illustrated on Figure 4-5.

Samples results are present in Appendices A.2 and A.3. Samples for TAL metal analysis were collected from Locations 2, 3, 12, 15 and 26, as well as a reference area. The highest concentrations of many of the TAL metals were obtained from the Location 2 sample. Notable concentrations in the location 2 sample (unfiltered data) include antimony at 150 ug/l (compared to nondetect in the reference area), arsenic at 554 ug/l (5.2 ug/l in the reference area), cadmium at 73 ug/l (nondetect in the reference area), copper at 115 ug/l (5.5 ug/l in the reference area), iron at 42,700 ug/l (9,870 ug/l in the reference area), lead at 11,100 ug/l (26.4 ug/l in the reference area), and zinc at 568 ug/l (nondetect in the reference area). Filtered water samples also were collected from these locations, and while the results were lower than those obtained from the unfiltered aliquots, significant concentrations of lead and other metals were still present.

4.4 GROUNDWATER

Groundwater sampling in May 1990 consisted of collecting samples from monitoring wells MW-1, -2, -3, -4, and -5. Samples were also collected from monitoring wells MW-1, -2, -3, and -5 in November 1990. During the ERRB 1994 sampling event, samples were collected from monitoring wells MW-1, -2, -3, -4, -5, -6, and -8. During the B&V 1995 sampling event, samples were collected from monitoring wells MW-1, -2, and -3. During the SESD 1996 sampling event, nine temporary wells and monitoring wells MW-1, -2, -3, -4, -5, -7, and -8 were sampled. The PRC 1997 sampling event consisted of installing and sampling nine new monitoring wells (MW-9, -10, -11, -12, -13, -14, -15, -16, and -17) and two temporary wells; an additional sample was collected from a wastewater treatment plant well located west of the RM site.

Analytical results of groundwater samples revealed the presence of several inorganic compounds at concentrations that either exceed the primary or secondary drinking water standards or the State of Tennessee domestic water supply criteria. Aluminum, arsenic, cadmium, lead, manganese, and nickel were detected above respective guidance concentrations. Lead concentrations in filtered groundwater samples ranged from nondetectable to 770 micrograms per liter (*u*g/l); the EPA action level for lead in groundwater is 15 *u*g/L.

Prior to the May 1997 sampling event, only unfiltered groundwater samples were collected. Even using low flow sampling techniques, many of these samples were characterized by very high turbidity (some samples as high as 500 nephelometric turbidity units [NTU]). In addition, later sampling events did not replicate the high lead concentrations measured in samples from several wells during earlier sampling events. Based on these observations, it is not clear if historic data are reliable.

During the May 1997 sampling event, both unfiltered and filtered groundwater samples were collected from selected monitoring wells to better define the extent of lead contamination and increase the reliability of the data set. Using only the filtered data set from the May 1997 sampling event, it appears that groundwater lead contamination is limited to an area just east and downgradient of the RM wrecker building. Under this assumption, the horizontal extent of the contaminant plume is about 300 feet by 200 feet. In contrast, using groundwater quality data from all historic unfiltered samples, combined with unfiltered and filtered data from the May 1997 sampling event, it could be interpreted that groundwater contamination is site-wide. In this case, the entire site would be considered a source. Under this assumption, the horizontal extent of the contaminant plume is at least 800 feet by 450 feet and extends off site.

Note that the groundwater contamination observed in MW11, MW17 and TW15 might not be expected considering the groundwater flow directions established using 1990 and 1996 data (see figures 2-8 and 2-9). However, the old fenced area of the site includes a curb that was constructed to divert storm water runoff to a storm water collection sump in the northeast corner of the facility. The sump can overflow during rain events, creating runoff at the northeast corner of the old fenced area. The runoff can migrate east and northeast of the old fenced area (where wells MW11, MW17 and TW15 are located) and enter groundwater by filtration.

The vertical extent of groundwater contamination has not been determined. Monitoring wells at the site typically terminate 20 to 30 feet bgs. Groundwater sample results are illustrated on Figure 4-3.

4.5 WASTE SLAG

Two samples of the waste slag were collected in November 1990, and one waste slag sample was collected during each of the 1996 and 1997 sampling events. Slag samples contained total lead concentrations ranging from 18,500 to 94,800 milligrams per kilogram (mg/kg). Samples that were also analyzed for TCLP lead exhibited concentrations ranging from 140 to 1,700 milligrams per liter (mg/L). These concentrations exceed the allowed TCLP maximum level of 5 mg/L. Sample results are illustrated on Figure 4-1.

4.6 BUILDING STRUCTURES

Three wipe samples of dust were collected from the furnace and raw materials refinery building: one floor wipe sample was collected during the 1994 sampling event, and two wipe samples from the furnace and raw materials refinery building were collected during the 1996 sampling event. Total lead and TCLP lead concentrations in the floor wipe sample were 14,700 mg/kg and 574 mg/L, respectively. The two wipe samples contained total lead concentrations ranging from 64,000 to 2,000,000 micrograms per 100 square centimeters. Sample results are illustrated in Figure 4-1.

5.0 BASELINE RISK ASSESSMENT

5.1 INTRODUCTION

The primary purpose of this baseline risk assessment (BRA) is to provide a quantitative and qualitative understanding of the actual and potential risks to human health posed by the Ross Metals (RM) site if no further remediation or institutional controls are applied. The BRA consists of both a human health evaluation and an ecological risk assessment. Together, they will be used to:

- Determine whether further remedial action is necessary, and
- Establish remediation goals if further remedial action is necessary.

5.1.1 ORGANIZATION OF BASELINE RISK ASSESSMENT REPORT

The human health evaluation (Sections 5.2 through 5.8) follows the suggested outline for a baseline risk assessment report, Exhibit 9-1 in U.S. EPA's *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Interim Final* (RAGS) (EPA 1989a). Below is a brief description of each section.

- Section 5.2 is the data evaluation. Analytical data are tabulated, showing the occurrence and distribution of chemicals. From this list of organic and inorganic substances present at the site, the most significant in terms of toxicity, concentration, and frequency of occurrence are selected as chemicals of potential concern (COPCs).

- Section 5.3 is the exposure assessment. Potential exposure points and migration pathways are identified. Exposure point concentrations and exposure doses are calculated. Uncertainties associated with the exposure assessment are discussed.

- Section 5.4 is the toxicity assessment. EPA toxicity values for each of the COPCs are presented.

- Section 5.5 is the risk characterization. The results of the data evaluation, exposure assessment, and toxicity assessment are combined to calculate an estimate of the risks to human health posed by chemicals at the site.

- Section 5.6 is the uncertainty analysis.
- Section 5.7 presents the Remediation Goal Options.
- Section 5.8 is the list of references used in the preparation of the human health evaluation.

In addition to the above-cited EPA guidance, this report conforms to the U.S. EPA's *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments)* (EPA 1997a). This information may be found in **Appendix B**.

The ecological risk assessment was prepared separately (EPA 1998a). A summary of the conclusions that were drawn and the methods that were employed is presented in Section 5.9. The report is reproduced in its entirety in **Appendix L.**

5.2 DATA EVALUATION

Data used in this risk assessment were obtained from the following sources: May and November 1990, Environmental Services Division (ESD) Resource Conservation and Recovery Act (RCRA) investigations; 1994 Emergency Response and Removal Branch (ERRB) investigation during a time-critical removal action; 1995 Black & Veatch investigation; November 1996 ESD investigation; the May 1997 PRC investigation; and the 1997 Emergency Response Team Center (ERTC) investigation. These data were evaluated by ESD personnel and determined to be of acceptable quality for use in a Baseline Risk Assessment. Sample locations are shown in Figures 3-1 and 4-1.

Because of the nature of the plant's operations, the majority of the samples were analyzed for Target Analyte List (TAL) parameters (inorganics) only. Two samples collected by ERTC were analyzed for the entire Target Compound List/Target Analyte List (TCL/TAL) parameters.

5.2.1 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

The laboratory results were validated by EPA Region IV ESD personnel using standard data validation procedures. They concluded that with the exception of a small percentage of the data that were rejected for a variety of technical reasons, the overall data package can be accepted with confidence.

The data were then summarized to show all inorganic and organic chemicals that were positively identified in at least one sample. Included in this group were unqualified results and results that were qualified with a "J" which means the chemical was present but the concentration was estimated. These values were listed as actual detected concentrations which may have the effect of under- or over-estimating the actual concentration. Tentatively identified compounds (qualified with an "N") were included if there was reason to believe that they were present. For example, if a compound was positively identified in other locations, the tentative identification was considered sufficient.

Laboratory data were segregated by medium and location and tabulated to show the occurrence and distribution of chemicals in surface soil, sediment, surface water, and groundwater. Each table shows the range of detections above the sample quantitation limit (SQL), arithmetic means of positive detections above the SQL, the number of detections above the SQL, the number of samples that were collected, and the site-specific background concentration levels.

These positively identified chemicals were then screened to exclude chemicals that, although present, are not important in terms of potential health effects. The screening criteria fall into three categories:

(1). Inorganics whose maximum detected concentration did not exceed two times the average background concentration were excluded;

(2). Inorganics that are essential nutrients or are normal components of human diets were excluded. Calcium, magnesium, potassium, and sodium were excluded because they are essential nutrients, with no known toxic effects at any relevant dosage level; and

(3). Inorganic and organic chemicals whose maximum concentration was lower than a risk-based concentration corresponding to an excess cancer risk level of 1 x 10^{-6} or a Hazard Quotient (HQ) level of 0.1, as determined by EPA Region III toxicologists using residential land use assumptions, were excluded (EPA 1998b).

Tables 5-1through **5-5** show the screening level (if applicable) for each chemical, and whether the chemical is a Chemical of Potential Concern (COPC). For each chemical that is not a COPC, an explanation code is provided to indicate the reason for its exclusion. The constituents that were not excluded for one or more of the reasons cited above are the COPCs presented in **Tables 5-6** through **5-10**.

5.3 EXPOSURE ASSESSMENT

An exposure assessment identifies pathways whereby receptors may be exposed to site contaminants and estimates the frequency, duration, and magnitude of such exposures. Exposure assessment involves (1) characterization of the environmental setting; (2) identification of exposure pathways; and (3) quantification of exposure. The environmental setting is discussed in Section 2; the remaining topics are presented below.

5.3.1 IDENTIFICATION OF EXPOSURE PATHWAYS

Exposure pathways are determined in a conceptual site model that incorporates information on the potential chemical sources, affected media, release mechanisms, potential exposure pathways, and known receptors to identify complete exposure pathways. A pathway is considered complete if (1) there is a source or chemical release from a source; (2) there is an exposure point where contact can occur; and (3) there is a route of exposure (oral, dermal, or inhalation) through which the chemical may be taken into the body.

The conceptual site model for this assessment is presented in **Figure 5-1**. As seen in this figure, metals, notably lead, are the primary contaminants of concern (COC) associated with the site; these contaminants are found in soils, structures, groundwater, and surface water. These contaminants are not typically highly mobile in the environment and move primarily by sediment

Figure 5-1
Conceptual Site Model
Ross Metals Site
Rossville, Tennessee

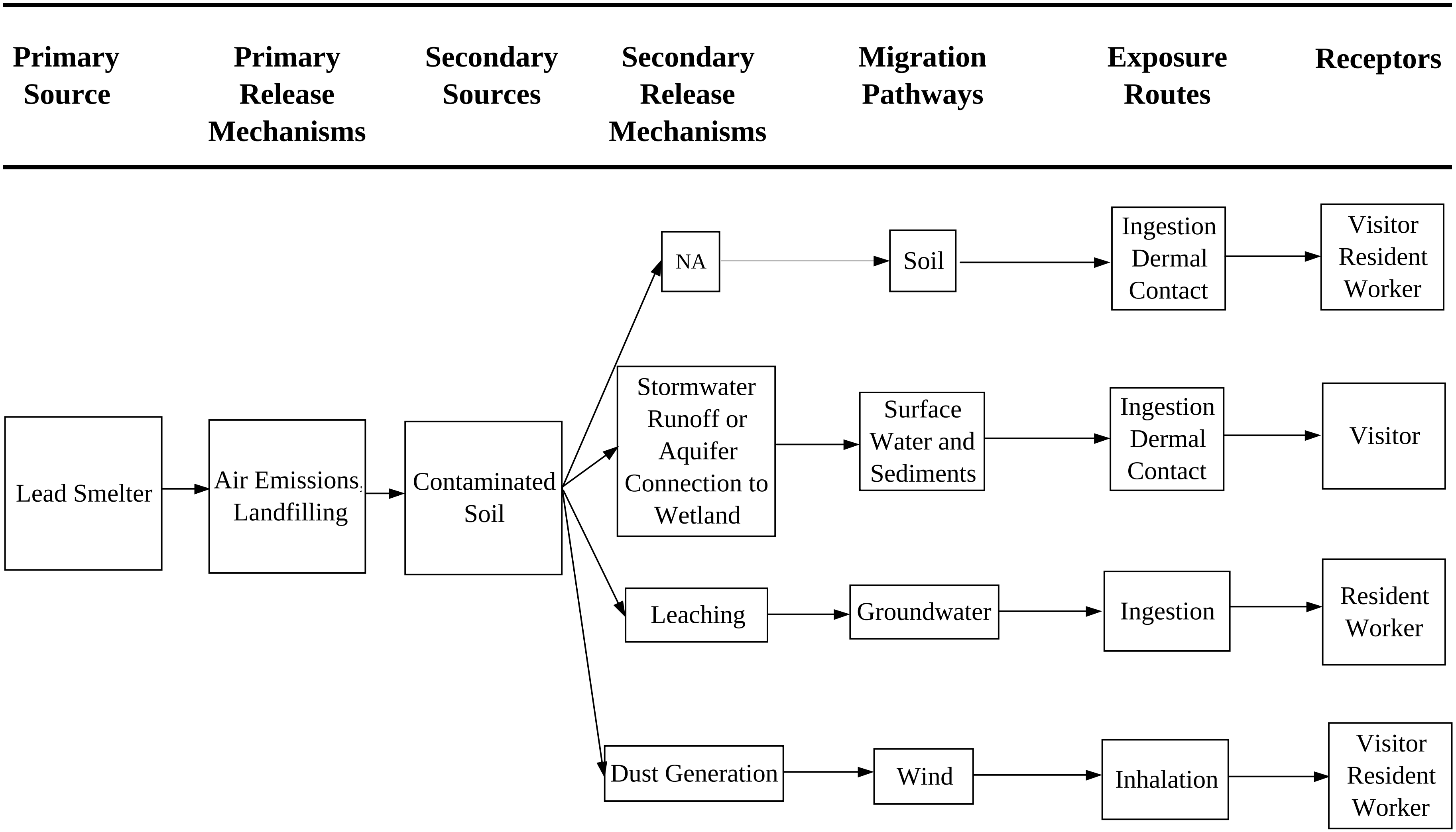

Table 5-1
Occurrence and Distribution of Chemicals in Soil
Process Area
Ross Metals Site
Rossville, Tennessee

Parameter	Medium (1)	Minimum (2)	Maximum (2)	Average (3)	Detects (4)	Samples (5)	Back-ground (6)	1E-6 / HQ 0.1 Risk Level (7)	COPC (8) (Y/N)
Aluminum	SS	350	15,000	7,322	21	21	11,620	7,800	N/BKG
Antimony	SS	7	730	182	9	25	2.1	3.1	Y
Arsenic	SS	3	479	50	25	26	5	0.45	Y
Barium	SS	19	790	111	21	21	95	550	Y
Beryllium	SS	0.4	0.4	0.4	1	21	0.4	0.15	N/BKG
Cadmium	SS	0.1	99	15	16	26	0.4	4	Y
Calcium	SS	441	353,000	50,497	26	26	1,319	NA	N/NUT
Chromium	SS	3	21	13	21	21	14	39	N/BSL
Cobalt	SS	3	13	7	3	21	7	470	N/BSL
Copper	SS	6	712	82	18	21	12	310	Y
Iron	SS	1	30,100	12,305	23	26	16,100	2,300	N/BKG
Lead	SS	6	97,700	8,788	29	29	30	400	Y
Magnesium	SS	39	15,000	2,320	26	26	1,390	NA	N/NUT
Manganese	SS	2	560	193	26	26	559	180	N/BKG
Mercury	SS	1	1	1	1	21	0.1	2	N/BSL
Nickel	SS	11	127	38	9	21	11	160	N/BSL
Potassium	SS	15	2,300	622	16	26	805	NA	N/NUT
Selenium	SS	1	48	14	7	21	3	39	Y
Silver	SS	1	11	6	3	21	1	39	N/BSL
Sodium	SS	249	4,040	1,204	10	26	97	NA	N/NUT
Thallium	SS	6	6	6	1	21	7	1	N/BSL
Vanadium	SS	8	28	19	20	21	27	55	N/BSL
Zinc	SS	14	629	77	21	21	43	2,300	N/BSL

Footnotes:

(1) Surface soil (SS) samples: 01-SL A through 20-SLA (11/96); T4-SB-NW-3, T4-PB-S-7, and T4-MW2-SW-8; and Sump (1/98).
Multiple results (e.g. duplicates) were combined using the highest detected value, or a single detection, to represent that sample event.

(2) Minimum / maximum detected concentration above the sample quantitation limit (SQL). Units are mg/kg.

Table 5-1 (cont.)
Occurrence and Distribution of Chemicals in Soil
Process Area
Ross Metals Site
Rossville, Tennessee

Footnotes (cont.):

(3) Arithmetic average of constituent detections above the SQL

(4) Number of times constituent was detected above the SQL

(5) Number of samples taken and analyzed for the constituent. Samples included in the data set represent approximate extent of surficial contamination. Sample number varies based on the number of usable results.

(6) Background: average of samples BK-1, BK-2 and Ref. 1 using one-half the SQL for non-detects.

(7) Risk-based concentrations for residential soil obtained from: "Risk-Based Concentration Table, " Roy L Smith, Ph.D., EPA Region III Senior Toxicologist. Obtained on-line 4/23/98. Units are mg/kg.

(8) Rationale Codes:
BSL Below screening level
BKG Below 2 times background
NUT Essential nutrient

Acronyms:
HQ Hazard quotient
COPC Chemical of Potential Concern
NA Not applicable

Table 5-2
Occurrence and Distribution of Chemicals in Soil
Landfill Area
Ross Metals Site
Rossville, Tennessee

Parameter	Medium (1)	Minimum (2)	Maximum (2)	Average (3)	Detects (4)	Samples (5)	Back-ground (6)	1E-6 / HQ 0.1 Risk Level (7)	COPC (8) (Y/N)
Aluminum	SS	3,300	14,000	9,250	4	4	11,620	7,800	N/BKG
Antimony	SS	75	75	75	1	4	2	3.1	Y
Arsenic	SS	8	76	33	4	4	5	0.43	Y
Barium	SS	77	140	114	4	4	95	550	N/BSL
Cadmium	SS	1	22	8	3	4	0.4	4	Y
Calcium	SS	3,800	43,000	19,600	4	4	1,319	NA	N/NUT
Chromium	SS	12	17	15	4	4	14	39	N/BSL
Cobalt	SS	14	14	14	1	4	7	470	N/BSL
Copper	SS	14	63	29	4	4	12	310	N/BSL
Iron	SS	15,000	20,000	17,750	4	4	16,100	2,300	N/BKG
Lead	SS	35	42,400	5,964	11	11	30	400	Y
Magnesium	SS	920	3,100	1,780	4	4	1,390	NA	N/NUT
Manganese	SS	380	1,100	615	4	4	559	180	Y
Mercury	SS	0.3	0.3	0.3	1	4	0.1	2.3	N/BSL
Nickel	SS	14	18	16	3	4	11	160	N/BSL
Potassium	SS	480	800	653	3	4	805	NA	N/NUT
Selenium	SS	6.2	6	6	1	4	3	39	N/BSL
Sodium	SS	1,800	1,800	1,800	1	4	97	NA	N/NUT
Vanadium	SS	13	30	23	4	4	27	55	N/BSL
Zinc	SS	45	310	115	4	4	43	2,300	N/BSL

Footnotes:

(1) Surface soil (SS) samples: 022-SL A, 110-SLA, and111-SLA (11/96); RM-SS-02 (6/95); T4-LF-N-4, T4-LF-E-5, T4-LF/116, T4-LF/B12, T4-LF/G8, T4-LF/D6, and T4-LF/AO
Multiple results (e.g. duplicates) were combined using the highest detected value, or a single detection, to represent that sample event.

(2) Minimum / maximum detected concentration above the sample quantitation limit (SQL). Units are mg/kg.

(3) Arithmetic average of constituent detections above the SQL

Table 5-2 (cont.)
Occurrence and Distribution of Chemicals in Soil
Landfill Area
Ross Metals Site
Rossville, Tennessee

Footnotes (cont.):

(4) Number of times constituent was detected above the SQL

(5) Number of samples taken and analyzed for the constituent. Samples included in the data set represent approximate extent of surficial contamination. Sample number varies based on the number of usable results.

(6) Background: average of samples BK-1, BK-2 and Ref. 1 using one-half the SQL for non-detects.

(7) Risk-based concentrations for residential soil obtained from: "Risk-Based Concentration Table, " Roy L Smith, Ph.D., EPA Region III Senior Toxicologist. Obtained on-line 4/23/98. Units are mg/kg.

(8) Rationale Codes:
BSL Below screening level
BKG Below 2 times background
NUT Essential nutrient

Acronyms:
HQ Hazard quotient
COPC Chemical of Potential Concern
ND Not detected
NA Not applicable

Table 5-3
Occurrence and Distribution of Chemicals in Soil and Sediment
Wetland/Woodland Area
Ross Metals Site
Rossville, Tennessee

Parameter	Medium (1)	Minimum (2)	Maximum (2)	Average (3)	Detects (4)	Samples (5)	Back-ground (6)	1E-6 / HQ 0.1 Risk Level (7,8)	COPC (9) (Y/N)
Aluminum	SS/SD	3,390	24,000	11,850	46	46	11,620	7,800	Y
Antimony	SS/SD	1	1,350	126	14	42	2	3.1	Y
Arsenic	SS/SD	4	681	40	46	46	5	0.43	Y
Barium	SS/SD	53	610	131	46	46	95	550	Y
Beryllium	SS/SD	0.3	0.8	0.6	3	46	0.4	0.15	N/BKG
Cadmium	SS/SD	1	18	5	28	46	0.4	3.9	Y
Calcium	SS/SD	230	8,900	1,873	44	46	1,319	NA	N/NUT
Chromium	SS/SD	5	28	14	46	46	14	39	N/BSL
Cobalt	SS/SD	2	8	5	13	46	7	470	N/BSL
Copper	SS/SD	8	465	40	45	46	12	310	Y
Iron	SS/SD	4,790	40,000	16,706	46	46	16,100	2,300	Y
Lead	SS/SD	67	98,100	4,555	52	52	30	400	Y
Magnesium	SS/SD	378	2,800	1,289	46	46	1,390	NA	N/NUT
Manganese	SS/SD	25	1,500	436	46	46	559	180	Y
Mercury	SS/SD	0.1	1.1	0.2	13	46	0.1	2.3	N/BSL
Nickel	SS/SD	4	35	16	18	46	11	160	N/BSL
Potassium	SS/SD	244	2,190	1,005	31	46	805	NA	N/NUT
Selenium	SS/SD	1.5	84	10	13	46	3	39	Y
Silver	SS/SD	2.1	2	2	1	46	1	39	N/BSL
Sodium	SS/SD	270	1,300	618	8	46	97	NA	N/NUT
Strontium	SS/SD	12	21	16	8	8	11	4,700	N/BSL
Tin	SS/SD	9.6	18	14	5	8	5	4,700	N/BSL
Titanium	SS/SD	79.0	410	291	8	8	350	31,000	N/BSL
Vanadium	SS/SD	10.4	63.0	27.5	46	46	27	55	Y
Yttrium	SS/SD	5.0	12.0	9.2	8	8	8	39	N/BSL
Zinc	SS/SD	21	251	64	44	46	43	2,300	N/BSL
Fluoranthene	SS/SD	100	100	100	1	2	NA	310,000	N/BSL
Pyrene	SS/SD	110	110	110	1	2	NA	230,000	N/BSL
Butylbenzylphthalate	SS/SD	120	120	120	1	2	NA	1,600,000	N/BSL
Bis(2-Ethylhexyl)phthalate	SS/SD	1,000	2,400	1,700	2	2	NA	46,000	N/BSL

Chrysene	SS/SD	220	220	220	1	2	NA	88,000	N/BSL
Benzo(k)fluoranthene	SS/SD	74	74	74	1	2	NA	8,800	N/BSL
Benzo(a)pyrene	SS/SD	66	66	66	1	2	NA	88	N/BSL
Acetone	SS/SD	30	30	30	1	2	NA	780,000	N/BSL
2-Butanone	SS/SD	10	10	10	1	2	NA	4,700,000	N/BSL
n-Butylbenzene	SS/SD	25	25	25	1	2	NA	78,000	N/BSL
sec-Butylbenzene	SS/SD	4	4	4	1	2	NA	78,000	N/BSL
Ethylbenzene	SS/SD	55	55	55	1	2	NA	780,000	N/BSL
Isopropylbenzene	SS/SD	7.8	7.8	7.8	1	2	NA	78,000	N/BSL
Methylene chloride	SS/SD	6	11	8	2	2	NA	85,000	N/BSL
Naphthalene	SS/SD	20	20	20	1	2	NA	310,000	N/BSL
o-Xylene	SS/SD	61	61	61	1	2	NA	16,000,000	N/BSL
p & m Xylene	SS/SD	230	230	230	1	2	NA	16,000,000	N/BSL
n-Propylbenzene	SS/SD	39	39	39	1	2	NA	78,000	N/BSL
Toluene	SS/SD	55	55	55	1	2	NA	1,600,000	N/BSL
Trimethylbenzene, 1,2,4-	SS/SD	190	190	190	1	2	NA	390,000	N/BSL
Trimethylbenzene, 1,3,5-	SS/SD	55	55	55	1	2	NA	390,000	N/BSL

Footnotes:

(1) Surface soil (SS) and Sediment (SD) samples: 050-SL A through 079-SLA (11/96); RM-7,-8, and-9 (5/90); SS-2-1, -2, -3, and -4 (11/90); RM-SD-2, -3, and -4
RM-6-6 (5/90); T4-WTP-E-6, T4-LK/KO,T4 -Z2-8, T4-Z2-12, T4 -Z2-16, T4-Z2-20; and Locations 2, 3, 12, 15, and 26 (1/98).
Multiple results (e.g. duplicates) were combined using the highest detected value, or a single detection, to represent that sample event.

(2) Minimum / maximum detected concentration above the sample quantitation limit (SQL). Units are mg/kg for inorganics and ug/kg for organics.

(3) Arithmetic average of constituent detections above the SQL

(4) Number of times constituent was detected above the SQL

Table 5-3 (cont.)
Occurrence and Distribution of Chemicals in Soil and Sediment
Wetland/Woodland Area
Ross Metals Site
Rossville, Tennessee

Footnotes (cont.):

(5) Number of samples taken and analyzed for the constituent. Samples included in the data set represent approximate extent of surficial contamination.
Sample number varies based on the number of usable results.

(6) Background: average of samples BK-1, BK-2 and Ref. 1 using one-half the SQL for non-detects.

(7) Risk-based concentrations for residential soil obtained from: "Risk-Based Concentration Table, " Roy L Smith, Ph.D., EPA Region III Senior
Toxicologist. Obtained on-line 4/23/98. Units are mg/kg for inorganics and ug/kg for organics.

(8) Toxicity value surrogates:
n-Propyl benzene used for isopropylbenzene
selenium used for yttrium

(9) Rationale Codes:
BSL Below screening level
BKG Below 2 times background
NUT Essential nutrient

Acronyms:
HQ Hazard quotient
COPC Chemical of Potential Concern
NA Not applicable

Table 5-4
Occurrence and Distribution of Chemicals in Surface Water
Ross Metals Site
Rossville, Tennessee

Parameter	Medium (1)	Minimum (2)	Maximum (2)	Average (3)	Detects (4)	Samples (5)	Back-ground (6)	AWQC (7, 8, 9)		COPC (8) (Y/N)
Aluminum	SW	168	1,300	930	7	10	165	87	7	Y
Antimony	SW	8	150	66	7	10	30	14	8	Y
Arsenic	SW	18	554	109	9	10	4	0.018	8	Y
Barium	SW	41	240	90	10	10	58	1,000	8	N/BSL
Cadmium	SW	6	120	64	6	10	1	0.66	7	Y
Calcium	SW	14,300	110,000	46,740	10	10	32,000	NA		N/NUT
Cobalt	SW	8	40	25	3	10	3	220	9	N/BSL
Copper	SW	6	140	47	9	10	4	6.54	7	Y
Iron	SW	313	42,700	11,683	10	10	6,800	300	8	Y
Lead	SW	36	16,000	4,370	10	10	9	1.32	7	Y
Magnesium	SW	3,160	7,500	4,522	10	10	4,500	NA		N/NUT
Manganese	SW	229	5,520	1,970	10	10	840	50	8	Y
Mercury	SW	0.2	0.4	0.3	4	10	0.1	0.012	7	Y
Nickel	SW	7	44	25	4	10	45	610	8	N/BSL
Potassium	SW	2	2,700	453	6	10	2,450	NA		N/NUT
Selenium	SW	7	11	9	2	10	2	5	7	Y
Sodium	SW	4	110,000	27,145	10	10	1,900	NA		N/NUT
Thallium	SW	12.7	13.4	13.1	3	10	3	1.7	8	Y
Vanadium	SW	3	8	6	3	10	2	26	9	N/BSL
Zinc	SW	39	568	200	7	10	30	58.91	7	Y

Footnotes:

(1) Surface water (SW) samples: SW-2 through SW-5 (6/95), 079SW (11/96), and Locations 2, 3, 12, 15, and 26 (1/98).
Multiple results (e.g. duplicates) were combined using the highest detected value, or a single detection, to represent that sample event.
All data are unfiltered results .

(2) Minimum / maximum detected concentration above the sample quantitation limit (SQL). Units are ug/l.

(3) Arithmetic average of constituent detections above the SQL

Table 5-4 (cont.)
Occurrence and Distribution of Chemicals in Surface water
Ross Metals Site
Rossville, Tennessee

Footnotes:

(4) Number of times constituent was detected above the SQL

(5) Number of samples taken and analyzed for the constituent. Samples included in the data set represent approximate extent of contamination. Sample number varies based on the number of usable results.

(6) Background: SW-1 collected 6/95, using one-half the SQL for non-detects.

(7) AWQC, Freshwater Aquatic Life Criteria, water and organism consumption. Units are ug/l.

(8) AWQC, Human Health Criteria. Units are ug/l.

(9) Risk-based concentrations for tap water obtained from: "Risk-Based Concentration Table, " Roy L Smith, Ph.D., EPA Region III Senior Toxicologist. Obtained on-line 4/23/98. Units are ug/l.

(10) Rationale Codes:
- BSL Below screening level
- BKG Below 2 times background
- NUT Essential nutrient

Acronyms:
- AWQC Ambient Water Quality Criteria
- HQ Hazard quotient
- COPC Chemical of Potential Concern
- NA Not applicable

Table 5-5
Occurrence and Distribution of Chemicals in Groundwater
Ross Metals Site
Rossville, Tennessee

Parameter	Medium (1)	Minimum (2)	Maximum (2)	Average (3)	Detects (4)	Samples (5)	Back-ground (6)	1E-6 / HQ 0.1 Risk Level (7)	COPC (8) (Y/N)
Aluminum	GW	380	23,000	4,036	9	14	35	3,700	Y
Arsenic	GW	21	40	31	2	24	3	0.045	Y
Barium	GW	11	380	90	14	14	16	260	Y
Cadmium	GW	5	7	6	3	14	1	1.8	Y
Calcium	GW	2,600	110,000	22,629	14	14	3,300	NA	N/NUT
Chromium	GW	39	39	39	1	14	3	18	Y
Cobalt	GW	55	55	55	1	14	1	220	N/BSL
Iron	GW	1,300	64,000	16,940	10	14	20	1100	Y
Lead	GW	3	1,600	268	18	24	2	15	Y
Magnesium	GW	1,100	38,000	13,731	13	14	1,300	NA	N/NUT
Manganese	GW	130	5,600	2,059	10	14	3	84	Y
Nickel	GW	45	160	75	4	14	2	73	Y
Potassium	GW	450	4,400	1,390	14	14	700	NA	N/NUT
Sodium	GW	5,900	490,000	129,779	14	14	11,000	NA	N/NUT
Vanadium	GW	7	49	21	3	14	2	26	Y
Zinc	GW	28	240	79	6	14	3	1,100	N/BSL

Footnotes:

(1) Groundwater (GW) samples: 010TW through 018TW (11/96); MW-2 through MW-5, MW-8 through MW-17, and TW-04 (5/97).
MW-7 not used because it is outside plume. TW-10 not used because it was from same borehole as MW-10.
Multiple results (e.g. duplicates) were combined using the highest detected value, or a single detection, to represent that sample event.
All data are unfiltered results .

(2) Minimum / maximum detected concentration above the sample quantitation limit (SQL). Units are ug/l.

(3) Arithmetic average of constituent detections above the SQL

(4) Number of times constituent was detected above the SQL

Table 5-5 (cont.)
Occurrence and Distribution of Chemicals in Groundwater
Ross Metals Site
Rossville, Tennessee

Footnotes:

(5) Number of samples taken and analyzed for the constituent. Samples included in the data set represent approximate extent of contamination.
Sample number varies based on the number of usable results.

(6) Background: average of samples MW-1 collected 1/19/97 and 5/29/97, using one-half the SQL for non-detects.

(7) Risk-based concentrations for tap waterl obtained from: "Risk-Based Concentration Table, " Roy L Smith, Ph.D., EPA Region III Senior Toxicologist. Obtained on-line 4/23/98. Units are ug/l.

(8) Rationale Codes:
BSL Below screening level
BKG Below 2 times background
NUT Essential nutrient

Acronyms:
HQ Hazard quotient
COPC Chemical of Potential Concern
NA Not applicable

Table 5-5
Occurrence and Distribution of Chemicals in Groundwater
Ross Metals Site
Rossville, Tennessee

Parameter	Medium (1)	Minimum (2)	Maximum (2)	Average (3)	Detects (4)	Samples (5)	Back-ground (6)	1E-6 / HQ 0.1 Risk Level (7)	COPC (8) (Y/N)
Aluminum	GW	380	23,000	4,036	9	14	35	3,700	Y
Arsenic	GW	21	40	31	2	24	3	0.045	Y
Barium	GW	11	380	90	14	14	16	260	Y
Cadmium	GW	5	7	6	3	14	1	1.8	Y
Calcium	GW	2,600	110,000	22,629	14	14	3,300	NA	N/NUT
Chromium	GW	39	39	39	1	14	3	18	Y
Cobalt	GW	55	55	55	1	14	1	220	N/BSL
Iron	GW	1,300	64,000	16,940	10	14	20	1100	Y
Lead	GW	3	1,600	268	18	24	2	15	Y
Magnesium	GW	1,100	38,000	13,731	13	14	1,300	NA	N/NUT
Manganese	GW	130	5,600	2,059	10	14	3	84	Y
Nickel	GW	45	160	75	4	14	2	73	Y
Potassium	GW	450	4,400	1,390	14	14	700	NA	N/NUT
Sodium	GW	5,900	490,000	129,779	14	14	11,000	NA	N/NUT
Vanadium	GW	7	49	21	3	14	2	26	Y
Zinc	GW	28	240	79	6	14	3	1,100	N/BSL

Footnotes:

(1) Groundwater (GW) samples: 010TW through 018TW (11/96); MW-2 through MW-5, MW-8 through MW-17, and TW-04 (5/97).
MW-7 not used because it is outside plume. TW-10 not used because it was from same borehole as MW-10.
Multiple results (e.g. duplicates) were combined using the highest detected value, or a single detection, to represent that sample event.
All data are unfiltered results .

(2) Minimum / maximum detected concentration above the sample quantitation limit (SQL). Units are ug/l.

(3) Arithmetic average of constituent detections above the SQL

(4) Number of times constituent was detected above the SQL

Table 5-5 (cont.)
Occurrence and Distribution of Chemicals in Groundwater
Ross Metals Site
Rossville, Tennessee

Footnotes:

(5) Number of samples taken and analyzed for the constituent. Samples included in the data set represent approximate extent of contamination.
Sample number varies based on the number of usable results.

(6) Background: average of samples MW-1 collected 1/19/97 and 5/29/97, using one-half the SQL for non-detects.

(7) Risk-based concentrations for tap waterl obtained from: "Risk-Based Concentration Table, " Roy L Smith, Ph.D., EPA Region III Senior Toxicologist. Obtained on-line 4/23/98. Units are ug/l.

(8) Rationale Codes:
BSL Below screening level
BKG Below 2 times background
NUT Essential nutrient

Acronyms:
HQ Hazard quotient
COPC Chemical of Potential Concern
NA Not applicable

Table 5-7
Chemicals of Potential Concern in Soil
Landfill Area
Ross Metals Site
Rossville, Tennessee

Chemical of Potential Concern	Minimum (1)	Maximum (1)
Antimony	75	75
Arsenic	8	76
Cadmium	1	22
Lead	35	42,400
Manganese	380	1,100

(1) Minimum / maximum detected concentration above the sample quantitation limit (SQL). Units are mg/kg.

Table 5-9
Chemicals of Potential Concern in Surface Water
Ross Metals Site
Rossville, Tennessee

Chemical of Potential Concern	Minimum (1)	Maximum (1)
Aluminum	168	1,300
Antimony	8	150
Arsenic	18	554
Cadmium	6	120
Copper	6	140
Iron	313	42,700
Lead	36	16,000
Manganese	229	5,520
Mercury	0.2	0.4
Selenium	7	11
Thallium	13	13
Zinc	39	568

(1) Minimum / maximum detected concentration above the sample quantitation limit (SQL). Units are ug/l.

Table 5-9
Chemicals of Potential Concern in Surface Water
Ross Metals Site
Rossville, Tennessee

Chemical of Potential Concern	Minimum (1)	Maximum (1)
Aluminum	168	1,300
Antimony	8	150
Arsenic	18	554
Cadmium	6	120
Copper	6	140
Iron	313	42,700
Lead	36	16,000
Manganese	229	5,520
Mercury	0.2	0.4
Selenium	7	11
Thallium	13	13
Zinc	39	568

(1) Minimum / maximum detected concentration above the sample quantitation limit (SQL). Units are ug/l.

Table 5-10
Chemicals of Potential Concern in Groundwater
Ross Metals Site
Rossville, Tennessee

Chemical of Potential Concern	Minimum (1)	Maximum (1)
Aluminum	380	23,000
Arsenic	21	40
Barium	11	380
Cadmium	5	7
Chromium	39	39
Iron	1,300	64,000
Lead	3	1,600
Manganese	130	5,600
Nickel	45	160
Vanadium	7	49

(1) Minimum / maximum detected concentration above the sample quantitation limit (SQL). Units are ug/l.

Figure 5-1

or wind transport. No specific pH data for site soils are available; however, low pH will, in general, make metals more soluble and, therefore, more easily transportable from the site, and more bioavailable.

Primary mechanisms available for contaminant transport away from the site are stormwater runoff, rainwater infiltration to groundwater, and windblown dust movement. Each of these is discussed below.

- **Transport by Rainwater Runoff:** During rainfall, water moves through contaminated media on the site. Much of the storm water runoff within the fenced portion of the site is routed to the collection sump in the northeast corner and discharges off site at this location. In addition, no stormwater collection facilities exist for the landfill area, and stormwater either infiltrates to groundwater or is routed north and east of the landfill. Runoff to the west is prevented due to the presence of the City of Rossville wastewater treatment ponds. These ponds are bermed, and runoff towards this area is routed north of the site. Runoff from the site may carry contaminated soils, as well as dissolved contaminants, into the Wolf River located about 0.5 miles north of the site, although no data have been collected to support this conclusion. The Wolf River flows west, through Memphis, and into the Mississippi River.

- **Rainwater Infiltration to Groundwater:** Rain falling directly on-site or as runon to the site moves through contaminated soils and structures. This water picks up soluble contaminants, such as metals, and during periods of heavy rainfall, moves sediments containing contaminants. Most of the area is paved and a concrete curb extends around most of the site. However, much of the pavement is in poor condition, allowing water seepage at the pavement discontinuities and infiltration to groundwater. The curb was apparently constructed to divert stormwater runoff to the stormwater collection sump in the northeast corner of the site. This sump apparently overflows during rain events, creating off-site runoff flow at the northeast corner of the property. Runoff appears to continue to migrate east and northeast of the site, where it enters the groundwater by infiltration. Within the landfill area, water flowing through contaminated material (buried slag) infiltrates into groundwater.

- **Windblown Dust Movement:** The fenced portion of the site is essentially devoid of vegetative cover. During dry periods, high winds could transport contaminants away from the site with windblown dust. Little data is available to determine if this is a significant transport mechanism at the site. However, because of the minimal amount of data this transport mechanism must be considered significant.

Based on this understanding of the fate and transport of contaminants, and the potential for human contact, the following media/receptors were examined:

(1). Surficial soil/sediment in the Landfill Area and Wetland/Woodland Area. Potential receptors are site visitors. In the future, residents and/or workers are potential receptors in the Process Area and Landfill Area.

(2). Surface water in the Wetland/Woodland Area. Potential receptors site visitors.

(3). Groundwater beneath the Process Area and the Landfill Area. Potential receptors are future residents and/or workers.

Potentially complete exposure pathways examined in this risk assessment are:

- inadvertent ingestion of soil,
- dermal contact with soil,
- inhalation of dust,
- inadvertent ingestion of surface water,
- dermal contact with surface water, and
- ingestion of groundwater.

5.3.2 QUANTIFICATION OF EXPOSURE

5.3.2.1 Exposure Point Concentrations

Reasonable maximum exposure (RME) point concentrations for soil/sediment, and surface water were calculated according to EPA Region IV guidance using the lesser of the 95 percent upper confidence limit (UCL) on the arithmetic average for a lognormal distribution or the maximum detected value (EPA 1992a and 1995a). Where a COPC was not detected at a given location, one-half the SQL was used as a proxy concentration; however, if both the proxy concentration and the UCL exceeded the maximum detected value, the maximum detected value was used as the RME concentration. The RME concentrations for COPCs in surface soil/sediment are presented in **Tables 5-11, 5-12**, and **5-13** for the Process Area, Landfill Area, and Wetland/Woodland Area, respectively. An example RME calculation is provided in **Table C-1** of **Appendix C.** The RME concentrations for COPCs in surface water are presented in **Table 5-14**. The RME

Table 5-11

Table 5-12

Table 5-13

Table 5-14

concentrations for groundwater were also determined according to EPA Region IV guidance. In this case, the arithmetic averages of the concentrations of COPCs found in the contaminant plume were used as the RME concentrations (EPA 1995a). The RME concentrations for COPCs in groundwater are presented in **Table 5-15**.

5.3.2.2 Human Intakes

Human intakes were calculated for each chemical and receptor using the RME concentrations. Estimates of human intake, expressed in terms of mass of chemical per unit body weight per time (mg/kg-day), were calculated differently depending on whether the COPC is a non-carcinogen or a carcinogen. For non-carcinogens, intake was averaged over the duration of exposure and is referred to as the average daily dose (ADD). For carcinogens, intake was averaged over the average lifespan of a person (70 years) and is referred to as the lifetime average daily dose (LADD). Chemical-specific intakes for each pathway are provided in **Appendix D** for the Process Area, **Appendix E** for the Landfill Area and **Appendix F** for the Wetland/Woodland Area. Sample calculations may be found in Appendix C.

ADDs and LADDs were calculated using standard assumptions and professional judgment. The assumptions that were used in calculating intakes are summarized in **Table 5-16** and are discussed below.

- **Body weight.** The body weights for the adult and the child receptors were 70 kg and 15 kg, respectively, in accordance with the guidance in EPA's *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (EPA 1991a). The body weight for the site visitor is 45 kg in accordance with EPA guidance (EPA 1995a).

- **Averaging time.** Based upon information in RAGS (EPA 1989a) for non-carcinogens, intakes were calculated by averaging the total cumulative dose over the exposure duration to yield an average daily intake. For the site visitor (exposure duration 10 years) the averaging time was 3,650 days. For the child resident (exposure duration 6 years) the averaging time was 2,190 days, and for the adult resident (exposure duration 24 years) the averaging time was 8,760 days. To calculate noncarcinogenic effects over a lifetime of exposure (estimated at 30 years), intake factors were calculated to account for the varying exposure rates and body weights over this time frame. See Table C-2 in Appendix C for the calculation of age-adjusted intake factors.

Table 5-15

Table 5-16

For carcinogens, intakes were calculated by averaging the total cumulative dose over a 70-year lifetime, an averaging time of 25,550 days, to yield a lifetime average daily intake.

- **Exposure frequency.** The site visitor was assumed to visit the site 50 days/year. Based upon information in the EPA document, *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (EPA 1991a), the standard default value for exposure frequency for commercial/industrial land use is 250 days/year, and for residential land use it is 350 days/year. These values were used for site workers, and for the child and adult resident receptors.

- **Exposure duration.** The exposure duration value for the site visitor from ages 7 to 16 is 10 years. This value is based on professional judgment. Based upon information in the EPA document, *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (EPA 1991a), the standard default value for exposure duration for commercial/industrial land use is 25 years and for residential land use it is 24 years for adults and 6 years for children. These values were used in assessing exposure for workers and for adult and child receptors. An exposure duration of 30 years was used to assess lifetime exposure to noncarcinogens.

- **Soil ingestion rate.** The ingestion rate of surficial soils for the site visitor was assumed to be 100 milligrams (mg)/visit. Based upon information in the EPA document, *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (EPA 1991a), the standard default values for soil ingestion for workers, child residents, and adult residents are 50, 100, and 200 mg/day, respectively. An age-adjusted intake factor was used to calculate noncancer risk for lifetime residents. (See Table C-2 in Appendix C).

- **Surface water ingestion rate.** The ingestion rate of surface water for a site visitor exposed during wading is 10 ml/hr based on EPA guidance (EPA 1995a).

- **Inhalation rate.** Based upon information in EPA documents, *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (EPA 1991a), the standard default inhalation rate for workers and adults is 20 m^3/day. The child resident inhalation rate of 10 m^3/day is based on the mean inhalation rate for a child, ages 6-8, in the *Exposure Factors Handbook* (EPA 1997b). The inhalation factor for the site visitor was based on the mean inhalation rate of 17 m^3/day for a male, ages 15-18 (EPA 1997b). An age-adjusted intake factor was used to calculate noncancer risk for lifetime residents. (See Table C-2 in Appendix C).

- **Surface area.** According to the *Dermal Exposure Assessment, Principles and Applications (Interim Report)* (EPA 1992b), dermal exposure to soil can be approximated as 25 percent of the total surface area. The 95th percentile total surface area of an adult male is 23,000 cm^2 and for a 6<7 year old male child it is 10,600 cm^2. After applying the 25 percent exposure factor, the surface area available for contact for adults was 5,800 cm^2 and for children it was 2,650 cm^2. The exposure area for a site visitor was assumed to be the same as that for an adult, 5,800 cm^2. An age-adjusted dermal factor was used to calculate noncancer risk for lifetime residents. (See Table C-2 in Appendix C). These surface areas were also applied to estimate dermal exposure of a site visitor to surface water in the wetland/woodland area.

- **Adherence factor.** The soil-to-skin adherence factor in assessing dermal exposure is between 0.2 and 1.0 mg/cm^2 according to EPA guidance (EPA 1995a). Since site-specific values are not available, 1.0 mg/cm^2 was conservatively selected.

5.4 TOXICITY ASSESSMENT

Toxicity assessment is a two-step process whereby the potential hazards associated with route-specific exposure to a given chemical are (1) identified by reviewing relevant human and animal studies; and (2) quantified through analysis of dose-response relationships. EPA has conducted numerous toxicity assessments that have undergone extensive review within the scientific community.

5.4.1 TOXICITY VALUES

EPA toxicity assessments and the resultant toxicity values will be used in the baseline evaluation to determine both carcinogenic and non-carcinogenic risks associated with each chemical of concern and route of exposure. EPA toxicity values that are used in this assessment include:

- reference dose values (RfDs) for non-carcinogenic effects
- cancer slope factors (CSFs) for carcinogenic effects

RfDs have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting non-carcinogenic (systemic) effects. RfDs are ideally based on studies where either animal or human populations were exposed to a given compound by a given route of exposure for the major portion of the life span (referred to as a chronic study). The RfD is derived by determining dose-specific effect levels from all the available quantitative studies, and applying uncertainty factors to the most appropriate effect level to determine an RfD for humans. The RfD represents a threshold for toxicity. RfDs are derived such that human lifetime exposure to a given chemical via a given route at a dose at or below the RfD should not result in adverse health effects, even for the most sensitive members of the population.

CSFs are route-specific values derived only for compounds that have been shown to cause an increased incidence of tumors in either human or animal studies. The CSF is an upper bound estimate of the probability of a response per unit intake of a chemical over a lifetime and is determined by low-dose extrapolation from human or animal studies. When an animal study is used, the final CSF has been adjusted to account for extrapolation of animal data to humans. If the studies used to derive the CSF were conducted for less than the life span of the test organism, the final CSF has been adjusted to reflect risk associated with lifetime exposure.

The RfDs and CSFs used in this assessment were primarily obtained from EPA's IRIS database (EPA 1998c). Values that appear in IRIS have been extensively reviewed by EPA work groups and thus represent Agency consensus. If no values for a given compound and route of exposure were listed in IRIS, then EPA's HEAST (EPA 1995b) were consulted. Where no value was listed in either IRIS or HEAST, EPA's National Center for Environmental Assessment (formerly the Environmental Criteria and Assessment Office) was consulted. **Tables 5-17** and **5-18** summarize the toxicity values for carcinogenic and non-carcinogenic COPCs, respectively. Brief toxicological profiles of the COPCs may be found in **Appendix G.**

Neither a CSF nor an RfD is available for lead. Instead, blood lead concentrations have been accepted as the best measure of exposure to lead. Because children are the most vulnerable to lead toxicity, EPA has developed an integrated exposure uptake biokinetic model (IEUBK) to assess chronic, non-carcinogenic exposures of children to lead. When this model is used, and the detected concentrations are shown to be acceptable to the most vulnerable group in the population (children), it is not necessary to address adult exposure.

To characterize risk associated with dermal exposure, the toxicity values presented in Tables 5-17 and 5-18 were adjusted from administered to absorbed toxicity factors according to the method described in Appendix A to RAGS (EPA 1989a). The following oral absorption percentages

Table 5-17

Table 5-18

were employed: 80 percent for VOCs, 50 percent for semi-volatile organics, and 20 percent for inorganics (EPA 1995a). The only exception to this was for arsenic. According to recently released EPA Region 4 guidance, the gastrointestinal absorption rate of arsenic may be considered 100 percent (Koporec 1998). Thus, when considering dermal exposure to arsenic, no adjustment is necessary.

5.5 RISK CHARACTERIZATION

The final step of the baseline risk assessment is the risk characterization. Human intakes for each exposure pathway (Section 5.3) are integrated with EPA reference toxicity values (Section 5.4) to characterize risk. Carcinogenic, non-carcinogenic, and lead effects are estimated separately.

To characterize the overall potential for non-carcinogenic effects associated with exposure to multiple chemicals, EPA uses a Hazard Index (HI) approach. This approach assumes that simultaneous subthreshold chronic exposures to multiple chemicals that affect the same target organ are additive and could result in an adverse health effect. The HI is calculated as follows:

$$\text{Hazard Index} = ADD_1/RfD_1 + ADD_2/RfD_2 + ...ADD_i/RfD_i$$

where: ADD_i = Average Daily Dose (ADD) for the ith toxicant

RfD_i = Reference Dose for the ith toxicant

The term ADD_i/RfD_i is referred to as the Hazard Quotient (HQ).

Calculation of an HI in excess of unity indicates the potential for adverse health effects. Indices greater than one will be generated anytime intake for any of the COPCs exceeds its RfD. However, given a sufficient number of chemicals under consideration, it is also possible to generate an HI greater than one even if none of the individual chemical intakes exceeds its respective RfD.

Carcinogenic risk is expressed as a probability of developing cancer as a result of lifetime exposure. For a given chemical and route of exposure, excess lifetime cancer risk is calculated as follows:

Risk = Lifetime Average Daily Dose (LADD) x Carcinogenic Slope Factor (CSF)

These risks are probabilities that are generally expressed in scientific notation (i.e., 1×10^{-6} or 1E-6). An incremental lifetime cancer risk of 1×10^{-6} indicates that, as a plausible upper-bound, an individual has a one-in-one-million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at the site. For exposures to multiple carcinogens, EPA assumes that the risk associated with multiple exposures is equivalent to the sum of their individual risks.

5.5.1 PROCESS AREA

5.5.1.1 Current Use Risk Summary

The Process Area presents physical and chemical risks to human health. The site contains numerous, unstable structures that pose physical risks to trespassers. Incidents involving unstable structures are potentially fatal and represent significant risk associated with the site. The condition of the structures will worsen over time, with a corresponding increase in associated hazards.

Apart from the physical hazards noted above, exposure to contaminants in soil in the Process Area is curtailed by the asphalt pavement that covers the great majority of the site and exposure to contaminated soils is not possible. Also, there are no groundwater wells in use that tap the contaminated zone of the aquifer. Thus, for these reasons, current exposure routes are incomplete.

5.5.1.2 Future Use Risk Summary

In the future, the site may be redeveloped for either residential or commercial/industrial use. Such redevelopment would expose the contaminated soils that exist beneath the pavement. Potential receptors would be site visitors, site worker, child residents, adult residents, and lifetime residents. In this future use scenario, ingestion of groundwater from wells developed from within the contaminant plume is considered as an additional exposure route for site workers, child residents, adult residents, and lifetime residents. Exposure routes potentially complete in such a scenario are:

- inadvertent ingestion of soil,
- dermal contact with soil,
- inhalation of dust, and
- ingestion of groundwater.

Table 5-19 summarizes the cancer and noncancer risks for these receptors. The calculations are in Appendix D. The total incremental lifetime cancer risk estimates range from 3×10^{-9} for the site visitor to 5×10^{-4} for the lifetime resident. In addition to the lifetime resident, risk estimates for the child resident and adult resident are above EPA's target range for Superfund sites. Arsenic in groundwater accounts for the excess cancer risk. Noncancer effects are possible for site workers, and child, adult, and lifetime residents based on HIs of 2, 25, 7, and 10, respectively. Exposure to antimony, arsenic, and iron in soil and arsenic, iron, and manganese in groundwater account for the majority of the potential non-cancer effects.

5.5.1.3 Exposure to Lead

Lead was detected in all Process Area soil samples at concentrations ranging from 6 to 97,700 mg/kg; the average concentration was 8,788 mg/kg. Lead was also detected in site groundwater at concentrations of 3 to 1,600 µg/l; the average concentration was 196 µg/l. These values were input into version 0.99d of the IEUBK model. The results are summarized in **Table 5-20**. The printout from the model is provided in **Appendix H**. EPA uses a level of 10 µg lead per deciliter (dl) blood as the benchmark to evaluate lead exposure. As can be seen, the projected blood lead

Table 5-19

Table 5-20
Projected Blood Lead Levels by Age Group
Process Area
Ross Metals Site
Rossville, Tennessee

Blood Lead Levels (ug/dl)						
Year 0.5-1	**Year 1-2**	**Year 2-3**	**Year 3-4**	**Year 4-5**	**Year 5-6**	**Year 6-7**
40.5	47.4	45.7	45.4	41.4	38	35.4

Source: Integrated Exposure Uptake Biokinetic Model for Lead in Children, version 0.99d.

Assumptions:
Air concentration: 0.200 ug Pb/m3 (default)
Diet (default)
Soil and dust: 8,788 ug/g (average lead concentration in soil); Multiple Source Analysis
Drinking water: 196 ug/l (average concentration in plume)
Paint intake: 0.00 ug Pb/day (default)
Maternal contribution: Infant model (default)

levels exceeded this threshold for all age groups, indicating that lead concentrations are above the acceptable range.

To calculate a risk-based remediation goal (RBRG) for a site worker, EPA guidance in *Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* (EPA 1996) was used. This method results in the derivation of an RBRG to protect the fetus of a pregnant worker. The guidance describes the basic algorithms that are used in the methodology and provides a set of default parameter values that can be used in cases such as this where high quality data are not available to support site-specific estimates.

Among the parameters that have a significant bearing on the derivation of the RBRG are the Individual Blood Lead Geometric Standard Deviation (GSD_i) and the Baseline Blood Lead Concentration ($PbB_{adult,\ 0}$). The GSD_i is a measure of the inter-individual variability in blood lead concentrations in a population whose members are exposed to the same nonresidential environmental lead levels. EPA guidance estimates that 1.8 - 2.1 is a plausible range for GSD_i, based on an evaluation of available blood lead concentration data for different types of populations. GSD_i estimates on the high end of the range represent a heterogenous population; conversely, estimates on the low end of the range represent less heterogeneity. For this assessment, a midrange value of 2.0 was used for the GSD_i, since the demographics of the future worker population are unknown.

The $PbB_{adult,\ 0}$ is intended to represent the best estimate of a reasonable central value of blood lead concentration in women of child-bearing age who are not exposed to lead-contaminated nonresidential soil or dust at the site. Ideally, this information should be estimated in the blood lead concentrations obtained from a representative sample of adult women at the site. Lacking this information, EPA guidance recommends selecting a value in the range of 1.7 - 2.2 µg/dL depending on site-specific demographics. For this assessment, a value of 2.0 µg/dL was used because information on site-specific demographics was not available. This is the middle of the range of default values for baseline blood lead.

The resulting RBRG for a site worker is reported in **Table 5-21**; the spreadsheet showing the calculation is in Appendix I. Also shown in Table 5-21 is the RBRG for lead based on a residential scenario. For comparison, the range and average lead concentrations in the Process Area are presented. As can be seen, the average concentration of lead greatly exceeds the RBRGs for both a residential and a commercial/ industrial use of the site.

5.5.2 LANDFILL AREA

Current receptors are site visitors. Exposure routes potentially complete are:

- inadvertent ingestion of soil,
- dermal contact with soil, and
- inhalation of dust.

5.5.2.1 <u>Current Use Risk Summary</u>

The site is in a commercial/industrial area but is currently inactive; therefore, a site visitor is the only currently exposed receptor. **Table 5-22** summarizes the cancer and noncancer risks for a site visitor. The calculations may be found in Appendix E. The total incremental lifetime cancer risk estimate is 8×10^{-10}. This estimate is below EPA's target range for Superfund sites. Noncancer effects are not expected based on an HI less than one.

5.5.2.2 <u>Future Use Risk Summary</u>

In the future, the Landfill Area may be redeveloped for commercial/industrial use or it may be converted to residential use. Ingestion of groundwater is an additional exposure route that may exist in a future use scenario. **Table 5-23** summarizes the cancer and noncancer risks for the site, visitor, site worker, child resident, adult resident, and lifetime resident. The calculations are in Appendix E. The total incremental lifetime cancer risk estimates range from 8×10^{-10} for the site visitor to 5×10^{-4} for the lifetime resident. In addition to the lifetime resident, the risk estimate for the adult resident is above EPA's target range for Superfund sites. Arsenic in groundwater accounts for the excess cancer risk. Noncancer effects are possible for site workers, and child,

Table 5-21
Comparison of Soil Lead Concentrations and Risk-Based Remediation Goals for Lead in Soil
Process Area
Ross Metals Site
Rossville, Tennessee

Parameter	Medium (1)	Minimum (2)	Maximum (2)	Average (3)	Risk-Based Remediation Goal	
					Child (4)	Adult Worker (5)
Lead	SS	6	97,700	8,788	400	1,100

Units are mg/kg

Notes:

(1) Surface soil (SS) samples: 01-SL A through 20-SLA (11/96); T4-SB-NW-3, T4-PB-S-7, and T4-MW2-SW-8; and Sump (1/98). Multiple results (e.g. duplicates) were combined using the highest detected value, or a single detection, to represent that sample event.

(2) Minimum / maximum detected concentration above the sample quantitation limit (SQL)

(3) Arithmetic average of constituent detections above the SQL

(4) Risk-based remediation goals based on EPA's Integrated Uptake Biokinetic Model for Lead in Children

(5) Risk-based remediation goals based on EPA's Interim Approach to Assessing Risks Associated with Adult Exposures to Lead

Table 5-22

Table 5-23

adult, and lifetime residents based on HIs of 2, 18, 6, and 8, respectively. Exposure to arsenic, antimony, and cadmium in soil and arsenic, iron, and manganese in groundwater account for the majority of the potential non-cancer effects.

5.5.2.3 Exposure to Lead

Lead was detected in all Landfill Area soil samples at concentrations ranging from 35 to 42,400 mg/kg; the average concentration was 5,964 mg/kg. Lead was also detected in site groundwater at concentrations of 3 to 1,600 µg/l; the average concentration was 196 µg/l. These values were input into version 0.99d of the IEUBK model. The results are summarized in **Table 5-24**. The printout from the model is provided in Appendix H. EPA uses a level of 10 µg lead per deciliter (dl) blood as the benchmark to evaluate lead exposure. As can be seen, the projected blood lead levels exceeded this threshold for all age groups, indicating that lead concentrations are above the acceptable range.

As with the Process Area, EPA guidance in *Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* (EPA 1996) was used to calculate an RBRG for a site worker. The resulting RBRG is reported in **Table 5-25,** alongside the RBRG for lead based on a residential scenario. For comparison, the range and average lead concentrations in the Landfill Area are presented. As can be seen, the average concentration of lead greatly exceeds the RBRGs for both a residential and a commercial/industrial use of the site.

5.5.3 WETLAND/WOODLAND AREA

Future development in the Wetland/Woodland Area is restricted by local zoning. Therefore, the only receptors that may come into contact contaminants in this area are site visitors. Exposure routes potentially complete are:

- inadvertent ingestion of soil,
- dermal contact with soil,

Table 5-24
Projected Blood Lead Levels by Age Group
Landfill Area
Ross Metals Site
Rossville, Tennessee

Blood Lead Levels (ug/dl)						
Year 0.5-1	**Year 1-2**	**Year 2-3**	**Year 3-4**	**Year 4-5**	**Year 5-6**	**Year 6-7**
33.4	39.6	38.3	38.1	34.9	32.1	29.9

Source: Integrated Exposure Uptake Biokinetic Model for Lead in Children, version 0.99d.

Assumptions:
Air concentration: 0.200 ug Pb/m3 (default)
Diet (default)
Soil and dust: 5,964 ug/g (average lead concentration in soil); Multiple Source Analysis
Drinking water: 196 ug/l (average concentration in plume)
Paint intake: 0.00 ug Pb/day (default)
Maternal contribution: Infant model (default)

Table 5-25
Comparison of Soil Lead Concentrations and Risk-Based Remediation Goals for Lead in Soil
Landfill Area
Ross Metals Site
Rossville, Tennessee

Parameter	Medium (1)	Minimum (2)	Maximum (2)	Average (3)	Risk-Based Remediation Goal	
					Child (4)	Adult Worker (5)
Lead	SS	35	42,400	5,964	400	1,100

Units are mg/kg

Notes:

(1) Surface soil (SS) samples: 022-SL A, 110-SLA, and111-SLA (11/96); RM-SS-02 (6/95); T4-LF-N-4, T4-LF-E-5, T4-LF/116, T4-LF/B12, T4-LF/G8, T4-LF/D6, and T4-LF/AO
Multiple results (e.g. duplicates) were combined using the highest detected value, or a single detection, to represent that sample event.

(2) Minimum / maximum detected concentration above the sample quantitation limit (SQL)

(3) Arithmetic average of constituent detections above the SQL

(4) Risk-based remediation goals based on EPA's Integrated Uptake Biokinetic Model for Lead in Children

(5) Risk-based remediation goals based on EPA's Interim Approach to Assessing Risks Associated with Adult Exposures to Lead

- inhalation of dust,
- inadvertent ingestion of surface water, and
- dermal contact with surface water.

5.5.3.1 Current/Future Use Risk Summary

Table 5-26 summarizes the cancer and noncancer risks for a site visitor. The calculations may be found in Appendix F. The total incremental lifetime cancer risk estimate is 2×10^{-6}. This estimate is within EPA's target range for Superfund sites. Noncancer effects are not expected based on an HI less than one.

5.5.3.2 Exposure to Lead

Due to the intermittent exposure to lead in the Wetland/Woodland Area, the IEUBK model cannot be directly used to estimate blood lead levels. However, if a child were to visit this area as little as once per week (the same exposure frequency assumed for the site visitor), the child would establish a steady state blood lead level, and the risk to this child would be over EPA's acceptable level. This is because the lead concentration in the Wetland/Woodland Area (average concentration 4,555 mg/kg) is more than seven times the IEUBK-based residential remedial level for lead (400 mg/kg).

5.6 UNCERTAINTY ANALYSIS

The uncertainty analysis provides decision makers with a summary of those factors that significantly influence risk results and discusses the underlying assumptions that most significantly influence risk. This section discusses the assumptions that may contribute to over- or underestimates of risk.

5.6.1 UNCERTAINTIES RELATED TO GROUNDWATER DATA

The groundwater data that were used in this assessment contribute a significant degree of uncertainty to the overall assessment. Among the factors that should be considered are

Table 5-26

differences between the results of filtered and unfiltered groundwater, our understanding about the extent of groundwater contamination, and the use of a single sampling event to estimate risk in the future. Each of these issues is discussed briefly below.

There is a substantial difference between the filtered and unfiltered samples (taken at the same location and time), which adds to the uncertainty in the exposure concentration. If this difference is due to turbidity, then the concentration of lead and other COPCs would change as the turbidity changes. This would result in an increase or decrease in the exposure concentration and resultant risk.

Neither the vertical nor the horizontal extent of groundwater contamination has been defined; thus, the concentration of lead in the groundwater is not known with a high degree of confidence. The impact of this uncertainty is small because the most contaminated areas, which form the basis for the exposure point concentration, have been defined, and additional investigations would only define the less contaminated, periphery of the plume.

The data represent only a single sampling round, making an assessment of long term trends impossible. The presumption that contaminant concentrations will remain the same over time may overestimate the potential risk because dispersion and other natural processes are not accounted for.

5.6.2 UNCERTAINTIES RELATED TO EXPOSURE ASSESSMENT

The exposure scenarios contribute a considerable degree of uncertainty to the risk assessment. Actual exposure frequencies are unknown; estimates were based on available guidance. Actual exposure is not expected to exceed the values presented but may be much lower. The use of conservative assumptions in the exposure assessment is believed to result in a potential overestimate of risk. Actual site risk may be lower than the estimates presented here but is not likely to be greater.

5.6.3 UNCERTAINTIES RELATED TO TOXICITY INFORMATION

RfDs and CSFs for the COPCs were derived from EPA sources. RfDs are determined with varying degrees of uncertainty depending on such factors as the basis for the RfD (no-observed-adverse-effect-level, NOAEL vs. lowest-observed-adverse-effect-level, LOAEL), species (animal or human) and professional judgment. The calculated RfD is therefore likely overly protective, and its use may result in an overestimation of noncancer risk. Similarly, the CSFs developed by EPA are generally conservative and represent the upper-bound limit of the carcinogenic potency of each chemical.

There has been particular controversy regarding the oral slope factor for arsenic. A reassessment of the arsenic cancer slope factor by the Risk Assessment Forum (EPA 1989b; 1998c) concluded that the most appropriate basis for an oral quantitative estimate was a study that reported increased prevalence of skin cancer in humans as a consequence of arsenic exposure in drinking water. Based on this study, the Administrator of the EPA recommended that the Risk Assessment Forum's slope factor be adopted, but noted that the slope factor for arsenic is as much as an order of magnitude more conservative than other, similarly derived cancer slope factors. This indicates that the arsenic risks may be overestimated and the estimates could be modified downwards as much as an order of magnitude relative to risk estimates associated with most other carcinogens.

There is considerably less uncertainty regarding the toxicity of lead than for other chemicals regulated by EPA. Abundant human data have been used by EPA in the development of the IEUBK model and validation efforts are currently underway to improve the predictiveness of this model. The principal uncertainty regarding lead exposure is not knowing whether anyone will actually reside on the site in the future and whether such individuals would be exposed as postulated in this assessment (i.e., inadvertent ingestion, dermal contact, inhalation of dust released from soil and ingestion of contaminated groundwater).

5.6.4 UNCERTAINTIES RELATED TO RISK CHARACTERIZATION

Lead was detected throughout the Wetland/Woodland Area, however, its risk to human health was not quantified due to the intermittent nature of exposure. It is likely, therefore, that risks associated with exposure to these soils/sediments are understated.

5.7 REMEDIATION GOAL OPTIONS

Remediation goal options (RGOs) provide remedial design staff with long-term targets to use during analysis and selection of remedial alternatives. Ideally, such goals, if achieved, should both comply with applicable, relevant, or appropriate requirements (ARARs) and result in residual risks that fully satisfy the NCP (EPA 1990) requirements for the protection of human health and the environment. RGOs are guidelines and do not establish that cleanup to meet these goals is warranted.

RGOs were calculated for chemicals of concern (COCs) only. COCs are the most significant contaminants in an exposure scenario that exceeds an excess cancer risk level of 1×10^{-4} or an HI of 1. More specifically, COCs have individual excess cancer risk levels of 1×10^{-6} or an HQ of 0.1 in a given exposure scenario. COPCs that exceed a state or federal ARARs are also COCs.

RGOs are calculated by combining the intake levels of each COC from all appropriate exposure routes for a particular medium and rearranging the risk equations to solve for the concentration term (RGO). RGOs, calculated separately for cancer and non-cancer effects, correspond to incremental cancer risk levels of 1×10^{-4}, 1×10^{-5}, and 1×10^{-6} and HQs of 0.1, 1, and 3.

Table 5-27 presents the RGOs for soil based on residential land use. For carcinogens, RGOs are based on lifetime resident exposure assumptions; for non-carcinogens, RGOs are based on child resident exposure assumptions. This combination yields the lowest (most protective) set of RGOs. For comparison, RGOs for soil based on commercial/industrial land use are included in **Table 5-28**. Spreadsheets showing the RGO calculations are presented in **Appendix I**.

Table 5-27

Table 5-28

The RGO for lead was determined by EPA using the IEUBK model. Assuming no contribution of lead from drinking water, the RGO for lead using residential land use assumptions is 400 mg/kg. The derivation of the RGO for lead may be found in **Appendix J**.

Table 5-29 presents the RGOs and Applicable or Relevant and Appropriate Requirements (ARARs) for groundwater based on residential land use. As with soil, RGOs for carcinogens are based on lifetime resident exposure assumptions and RGOs for non-carcinogens are based on child resident exposure assumptions. Also included in Table 5-27 is the action level for lead of 15µg/l set by the EPA Office of Drinking Water and used as such by EPA Office of Solid Waste and Emergency Response. This action level would be protective for the sensitive child receptor assuming that soil lead levels are no greater than 255 mg/kg. For comparison, RGOs and ARARs for groundwater based on commercial/industrial land use are included in **Table 5-30**. Spreadsheets showing the RGO calculations are presented in Appendix I.

5.8 BASELINE RISK ASSESSMENT REFERENCES

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Table 5-29

Table 5-30

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5.9 ECOLOGICAL RISK ASSESSMENT SUMMARY

An ecological risk assessment was conducted to determine the potential for ecological risk at the site. This section summarizes the approach that was followed and the conclusions that were drawn. The report is reproduced in its entirety in Appendix L.

5.9.1 PROBLEM FORMULATION

The risk assessment was designed to evaluate the potential threats to ecological function from exposure to site contaminants and to establish site-specific clean-up levels for the contaminants of potential concern (COPCs). The problem formulation process included the identification of COPCs, the identification of exposure pathways, a determination of the assessment endpoints for the site, the formulation of testable hypotheses, the development of a conceptual model, and the determination of the measurement endpoints.

5.9.1.1 Identification of Contaminants of Potential Concern

A screening level risk assessment was used to identify COPCs. On the basis of concentration and toxicity, twelve metals (aluminum, antimony, arsenic, cadmium, copper, iron, lead, mercury, nickel, silver, thallium, and zinc), two semi-volatile organic compounds (bis(2-ethylhexyl)phthalate and butylbenzyl phthalate), and two volatile organic compounds (ethylbenzene and xylenes) exceeded the benchmark values and were identified as COPCs.

5.9.1.2 Exposure Characterization

Prior to the initiation of the ecological risk assessment, it was known that elevated levels of contaminants were present in the sediment, water, and possibly the biota on and adjacent to the site. Chemical analyses of sediment, water, and biota were used to determine the levels of contaminants in each area. Receptors are potentially exposed to contaminants in abiotic matrices through direct contact, intentional ingestion (e.g., consumption of water and food items), and incidental ingestion (e.g., sediment adhered to food items). Transfer of the contaminants to receptors could also occur through processes of bioaccumulation through the food chain, whereby higher trophic level receptors are exposed to site contaminants through the ingestion of contaminated prey items.

5.9.1.3 Selection of Assessment Endpoints

The ecological setting of the site consists of scrub/shrub habitat, drainages, wetlands, and a stream (Wolf River). This information helped identify ecological receptors and assessment endpoints. A variety of invertebrates, vertebrates, and plants inhabit the wetlands. In addition, many birds and mammals from adjacent habitats could prey on the wetland flora and fauna. Therefore, the viability of avian, mammalian, and wetland invertebrate, vertebrate and plant populations, as well as organism survivability were selected as assessment endpoints.

5.9.1.4 Production of Testable Hypotheses

The testable hypotheses are specific questions that are based upon the assessment endpoints. Two questions were asked: (1) Are levels of site contaminants in sediment enough to have an adverse effect on benthic invertebrate community structure and function? (2) Are levels of site contaminants in prey, sediment, and water sufficient to have an adverse effect on growth, survival and/or reproductive success of amphibians, insectivorous birds, carnivorous birds, herbivorous mammals, insectivorous mammals, and carnivorous mammals?

5.9.1.5 Conceptual Model

The conceptual model is based on contaminant and habitat characteristics to identify critical exposure pathways to the selected assessment endpoints. At the site, contaminants in the water and sediment may come in contact with the aquatic, benthic, and terrestrial receptors inhabiting the wetland and neighboring areas. Benthic invertebrates in the wetland may be exposed to site contaminants through direct contact and/or ingestion of the sediment and overlying water. Wetland vertebrates may be exposed to site contaminants via direct contact with water and sediment, ingestion of water, incidental ingestion of sediment adhered to food items, and ingestion of contaminated food. Mammals and birds may be exposed to site contaminants via ingestion of contaminated food, incidental ingestion of sediment, and ingestion of water.

5.9.1.6 Selection of Measurement Endpoints

Measurement endpoints are measurable ecological characteristics that are related to the valued characteristics selected as assessment endpoints. Measurement endpoints should be linked to the assessment endpoints by the mechanism of toxicity and the route of exposure. Measurement endpoints are used to derive a quantitative estimate of potential effects, and to form a basis for extrapolation to the assessment endpoints.

Measurement endpoints were selected on the basis of potential presence of receptors at the site, and the potential for exposure to contaminants of concern. The availability of the appropriate toxicity information on which risk calculations could be based was also an important consideration. Endpoints selected were determined to be representative of exposure pathways and assessment endpoints identified for the site.

5.9.2 METHODS

A field investigation was conducted to obtain site-specific contaminant concentrations in water, sediment, and biological tissue that would provide data necessary for the completion of the site risk assessment. A summary of the activities is presented below:

- Surface water and sediment samples were collected along a suspected contamination gradient in the adjacent wetlands and submitted for TAL metals analysis. The sediment samples were also submitted for toxicity evaluations.

- Surface water and sediment samples were collected two of the five locations along a suspected contaminant gradient and submitted for PCB, pesticide, base-, neutral, and acid-extractable, and volatile organic compound analysis. In addition, three frog samples were collected and submitted for tissue analysis of PCBs and pesticides.

- Three locations were identified along the Wolf River, "upstream," "midstream," and "downstream," from which sediment samples were submitted for TAL metals analysis.

- Plant, grasshopper, and frog samples were collected and submitted for tissue analysis of TAL metals. These site-specific tissue residue levels were used to predict the amount of contaminant transfer through trophic levels.

- Three plant samples were collected at five locations along a suspected contamination gradient and at Reference 1 and submitted for TAL metals analysis. A sediment sample was also collected directly below each plant and submitted for TAL metals analysis. A bioaccumulation factor was then calculated for each location by dividing the mean metal concentrations in the plant tissue by the mean metal concentrations in the sediment samples collected beneath the plants.

- Grasshoppers were collected on site and submitted for analysis of TAL metals. A mean bioaccumulation factor was calculated for the site by dividing the mean metal concentrations in the grasshoppers collected on site by the mean metal concentrations for all plants collected on site.

In addition to the above activities, the following investigative strategies were employed:

1) Solid-phase toxicity evaluations were conducted to determine the effects of direct contact with site contaminants to aquatic organisms.

2) Measured concentrations of each contaminant of concern in surface water were compared to literature-derived values on the toxicity to early life stages of amphibians.

3) The results of the analyses of water, sediment, and tissue were used in a food chain model to predict exposure dosages for each contaminant of concern to higher trophic levels.

5.9.3 CONCLUSIONS

The results of the analyses of the samples collected at the site indicated that it has been heavily contaminated with metals. Contamination extends both north and east of the site and into the adjacent wetlands. Of all the metals calculated to pose a potential risk, lead was determined to pose the highest risk to ecological receptors. It was also determined that organic contaminants are present at the site; however, the magnitude and extent of this contamination remains uncertain because of the small sample size. Wolf River has not been contaminated by releases from the site.

The following sections present the conclusions that were drawn regarding the viability of avian, mammalian, and wetland invertebrate, vertebrate and plant populations, as well as organism survivability. NOAEL and LOAEL ranges for each receptor group are presented in **Table 5-31**.

Table 5-31

5.9.3.1 Benthic Invertebrates

The results of the sediment toxicity tests determined that Location 3 is acutely toxic to benthic invertebrates. Therefore, it may be concluded that the site poses an acute risk to benthic invertebrate community structure and function. Contaminants that were determined to potentially pose this risk are 2-butanone, antimony, arsenic, antimony, arsenic, cadmium, copper, lead, and mercury.

5.9.3.2 Amphibians

The qualitative evaluation of the risk of surface water contamination at the site to early life stages of amphibians indicated that a potential risk is posed by aluminum, arsenic, cadmium, copper, iron, lead, and zinc. However, the risk of the contamination at the site to later life stages and via other routes of exposure for amphibians could not be determined.

5.9.3.3 Insectivorous Birds

The results of the food chain evaluation indicate that the levels of lead at the site are enough to pose a risk to survival, growth, and/or reproduction for insectivorous birds.

5.9.3.4 Carnivorous Birds

The results of the food chain evaluation indicate that the levels of lead at the site are enough to pose a risk to survival, growth, and/or reproduction for carnivorous birds.

5.9.3.5 Herbivorous Mammals

The results of the food chain evaluation indicate that the levels of aluminum, arsenic, cadmium, lead, and nickel at the site are enough to pose a risk to survival, growth, and/or reproduction for herbivorous mammals.

5.9.3.6 Insectivorous Mammals

The results of the food chain evaluation indicate that the levels of aluminum, arsenic, cadmium, lead, and nickel at the site are enough to pose a risk to survival, growth, and/or reproduction for insectivorous mammals.

5.9.3.7 Carnivorous Mammals

The results of the food chain evaluation indicate that the levels of aluminum, arsenic, and lead at the site are enough to pose a risk to survival, growth, and/or reproduction for carnivorous mammals.

6.0 CONTAMINANT FATE AND TRANSPORT

Metals, notably lead, are the primary contaminants of concern (COC) associated with the site; these contaminants are found in soils, structures, groundwater, and surface water. These contaminants are not typically highly mobile in the environment and move primarily by soil/sediment or wind transport.

Primary mechanisms available for contaminant transport away from the RM site are rainwater runoff, rainwater infiltration to groundwater, and windblown dust movement. A conceptual site model is presented in **Figure 6-1**. The following transport mechanisms may affect contaminants at the RM site:

- **Rainwater Infiltration to Groundwater:** Rain falling directly on site or as runon to the site moves through contaminated soils and structures. This water picks up soluble contaminants, such as metals, and during periods of heavy rainfall, moves sediments containing contaminants. Most of the area is paved and a concrete curb, which was built some years after the facility began operation, extends around most of the old fenced area. However, much of the pavement is in poor condition, allowing water seepage at the pavement discontinuities and infiltration to groundwater. The curb was apparently constructed to divert storm water runoff to the storm water collection sump in the northeast corner of the old fenced area. This sump apparently overflows during rain events, creating runoff flow at the northeast corner of the property. Runoff appears to continue to migrate east and northeast of the old fenced area, where it enters the groundwater by infiltration. Within the landfill area, water flowing through contaminated material (buried slag) infiltrates into groundwater.

- **Windblown Dust Movement:** The old fenced portion of the RM site is essentially devoid of vegetative cover. During dry periods, high winds could transport contaminants away from the site with windblown dust. When the facility was in operation, wind could have transported contaminants in air coming from the exhaust stack away from the site. Little data is available to determine if this is a significant transport mechanism at the RM site. However, because of the minimal amount of data this transport mechanism must be considered significant.

Fig. 6-1

- **Transport by Rainwater Runoff:** During rainfall, water moves through contaminated media on the site. Much of the storm water runoff within the fenced portion of the site is routed to the collection sump in the northeast corner and discharges off site at this location. In addition, no stormwater collection facilities exist for the landfill area, and stormwater either infiltrates to groundwater or is routed north and east of the landfill. Runoff to the west is prevented due to the presence of the City of Rossville wastewater treatment ponds. These ponds are bermed, and runoff towards this area is routed north of the site. Runoff from the site may carry contaminated soils, as well as dissolved contaminants, into the Wolf River located about 0.5 miles north of the site, although no data have been collected to support this conclusion. The Wolf River flows west, through Memphis, and into the Mississippi River.

The RM facility likely released lead in spills of battery acid, metallic or oxidized lead from improper storage or disposal of battery plates or casings, airborne fallout from the smelter, and the smelter slag.

The solubility of lead minerals and complexes increases as pH decreases (Lindsay 1979). No specific pH data for site soils are available; however, a sustained leak of battery acid would neutralize soil alkalinity, lowering the soil pH and increasing lead mobility in the soil. At the RM site, spills of battery acid may have transported lead deep into the soil profile and to the aquifer.

Lead from the improper disposal of battery parts may be released to the environment as metallic lead or lead oxide. Metallic lead oxidizes slowly to lead oxide, and lead from airborne fallout is probably released to the environment as lead oxide. Lead oxides are relatively soluble when compared to lead sulfates, phosphates, and carbonates. The smelter slag contained very high concentrations of lead; however, the slag is relatively inert.

Metal mobility in soil-waste systems is determined by the type and quantity of soil surfaces present, contaminant concentrations, concentrations of competing ions and ligands, pH, and redox status. For this reason, the use of literature or laboratory data that do not mimic the specific site soil and waste system are not generally adequate to describe or predict the behavior of the contaminant. In order to help determine the fate of lead contamination at the RM site, several site fate and transport models were completed as part of the EE/CA completed for the site.

A one-dimensional geochemical model was used to evaluate the migration of lead in soil beneath the smelter slag and the migration of lead below the contaminated soil near the wrecker building. The model suggested that the slag material is a potential source of contamination to groundwater. The model predicted that lead will migrate to groundwater in six years and the concentration of lead in groundwater will exceed 15 ug/l in 55 years. In addition the geochemical model suggested that soils near the wrecker building are acting as a continuing source of contamination to groundwater and that lead concentration in groundwater will continue to increase (reaching a maximum of 23,600 ug/l in 57 years) unless the source is removed.

A Hydrologic Evaluation of Landfill Performance (HELP) quasi-two-dimensional hydrologic model of water movement across, into, through, and out of landfills, coupled with the results of the geochemical modeling suggest that the construction of a geosynthetic cap will effectively eliminate the potential for future groundwater contamination.

A Well Head Protection Area (WHPA) model was used to determine the number of extraction wells, well locations, and well discharge rates for the optimal configuration of a pump-and-treat system for groundwater remediation. Finally, a Random-Walk model was completed to simulate the progress of remediation for the various remediation scenarios developed for the WHPA modeling. The Random-Walk modeling suggested that a 15 ug/l groundwater action level for lead cannot be attained under a "no action" scenario. The Random-Walk modeling also predicted remediation durations for various pump and treat scenarios. However, the results of the Random-Walk modeling must be considered cautiously.

In the Random-Walk model, the retardation factor for lead was assumed to be 1. A retardation factor of 1 implies that the calculated movement of lead is unretarded relative to the movement of groundwater, and that the contaminant can be removed from the aquifer as easily as water.

Considering the geology of the site and the characteristics of lead, a retardation coefficient of 1 probably does not adequately represent actual conditions. In addition, the model uses an effective porosity of 25% while the total porosity of the silty clay is 42% and the sand aquifer is 39%. The difference between the total and effective porosity should be less than about 5% (Newell and Mcleod, 1996). Because the model is based on a retardation coefficient of 1, and an effective porosity of 25%, it may lead to an overly optimistic assessment of the time and cost needed to remediate the contaminant plume or even if the plume can be effectively remediated through a pump-and-treat alternative.

In an attempt to more realistically assess the time and cost needed to remediate the contaminant plume, the Random-Walk Model was run again for this RI/FS. The pump-and-treat scenarios evaluated for the EE/CA were evaluated for the RI/FS. However, more appropriate values were included as retardation coefficient and effective porosity. A retardation value of 45 was calculated using data from the EE/CA modeling report. An effective porosity of 35% was assumed. The results of the revised Random-Walk Model run show that after 100 years, none of the pump and treat scenarios developed for the EE/CA were able to reduce lead concentration in groundwater to below 100 ug/l. The revised model run suggests that pump and treat may not be a viable remedial alternative to reduce the maximum lead in water concentration to below the action level of 15 ug/l, due to the length of time (greater than 100 years) required by the alternative.

While the modeling efforts completed for the EE/CA and the RI/FS provide more site-specific information regarding the fate and transport of lead contamination, the results should be used cautiously. The completed modeling applications are considered interpretive. Interpretive models are useful as a framework for studying system dynamics and for analyzing flow and transport in hypothetical or assumed hydrogeologic systems. However, interpretive models cannot be used to accurately predict the future concentrations of contaminants in groundwater. This means that additional site-specific information is needed to assess aquifer characteristics and water-bearing properties to validate model results and even to accurately evaluate the potential to successfully implement a "pump-and-treat" remediation. Refer to **Appendix K** for additional information on the modeling completed for the EE/CA as well as this RI/FS.

In addition to lead, other inorganics also were identified as human health or ecological COCs. Aluminum's behavior in the environment depends on its chemistry and surrounding conditions. In soils, a low pH generally results in an increase in aluminum mobility. Plants vary in their ability to remove aluminum from soils. Biomagnification of aluminum in terrestrial food chains does not appear to occur (ASTDR 1990).

Antimony's adsorption to soil and sediment is primarily correlated with iron, manganese, and aluminum content (ASTDR 1991). Antimony can be reduced and methylated by microorganisms in anaerobic sediment, releasing volatile methylated antimony compounds into water (ASTDR 1991).

Arsenic has four valence states (-3, 0, +3, +5) but rarely occurs in its free state in nature. Inorganic arsenic is more mobile than organic arsenic and poses greater problems by leaching into surface waters and groundwaters.

Lead does not magnify to a great extent in food chains. Older organisms typically contain the highest tissue lead levels (Eisler 1988). Plants can uptake lead through surface deposition in rain, dust, and soil, or by uptake through roots. A plant's ability to uptake lead from soils is inversely related to soil pH and organic matter content.

7.0 REMEDIAL INVESTIGATION CONCLUSIONS

7.1 SOIL/SEDIMENT

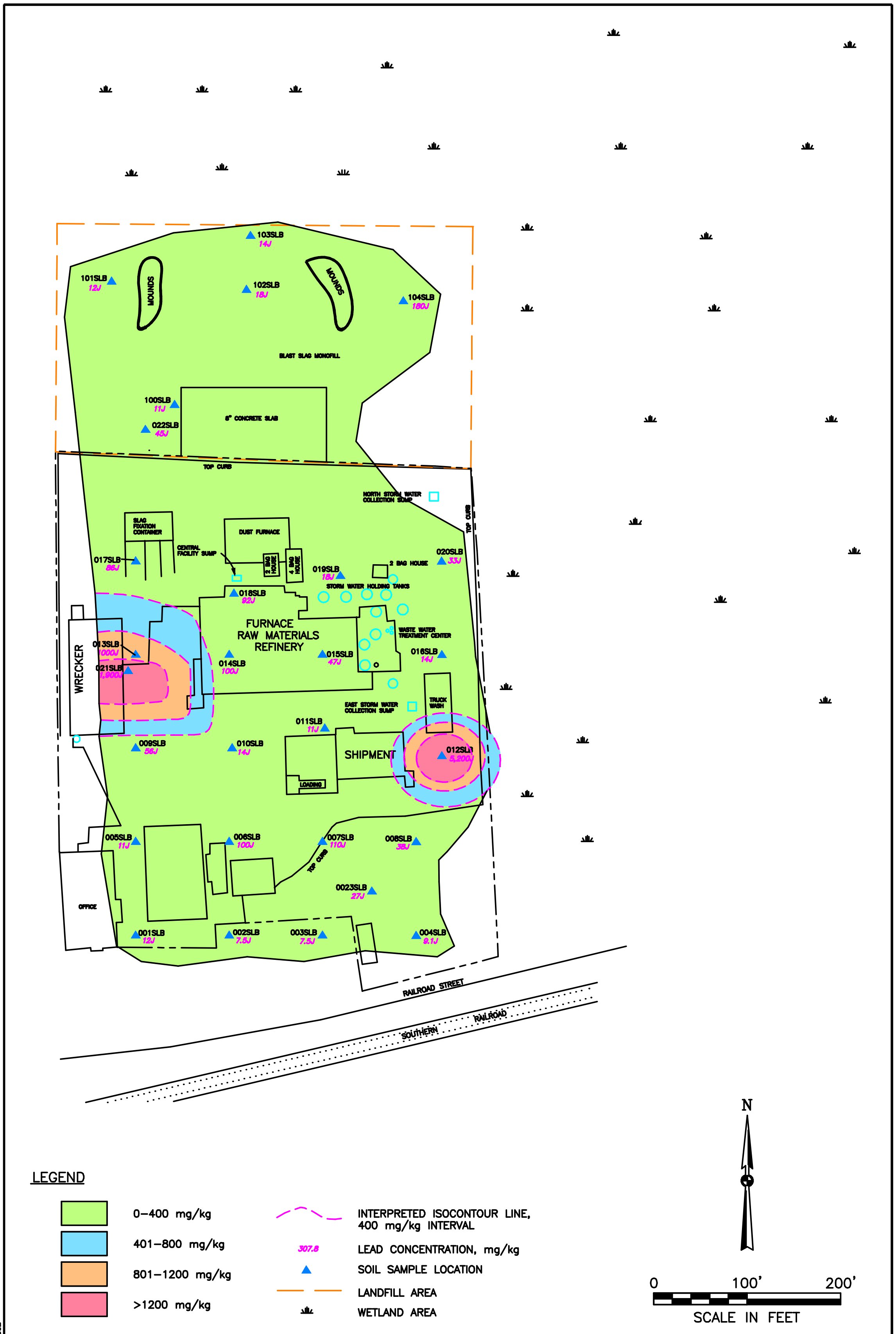
Surface soil and sediment samples were collected at depths of up to 2 feet bgs. Lead-contaminated surface soil is present across the site and in the wetlands north and east of the facility. Lead concentrations in most surface soil and sediment samples collected throughout the site exceeded 400 ppm. In addition, aluminum, antimony, arsenic, barium, cadmium, copper, iron, manganese, selenium, and vanadium were detected above risk-based remedial goal option (RGO) levels. **Figure 7-1** illustrates the extent of surface soil lead contamination throughout the site. Additional samples collected as part of an ecological risk assessment and analyzed using both XRF analysis and ICP procedures showed a widespread presence of lead and other COCs defined in the risk assessment above RGO levels in the wetlands north and east of the site. **Figure 7-2** illustrates lead concentration contours in the wetlands based on XRF samples collected in December 1997.

The highest levels of subsurface soil contamination were found in two isolated locations at the site; east of the wrecker building, and southeast of the truck wash. **Figure 7-3** illustrates the extent of subsurface soil lead contamination at the site. Elevated lead concentrations were collected at depths ranging from 18 to 40 inches beneath the pavement near the wrecker building and the truck wash and at depths of up to 5.5 feet in the landfill, however, as Figure 7-3 indicates, none of the soil samples collected from beneath the buried slag exhibited lead concentrations in excess of the RGO level.

In addition to soils, other solid media were sampled during previous investigations. Waste slag samples contained total lead concentrations ranging from 18,500 to 94,800 milligrams per kilogram (mg/kg). Total lead and TCLP lead concentrations in a floor wipe sample collected from the furnace and raw materials refinery building were 14,700 mg/kg and 574 mg/L, respectively.

fig 7-1

fig 7-2



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Ross Metals Site **Rossville, Tennessee**	**Extent of Lead in Subsurface Soils**	**Figure No.** **7–3**
CDM Federal Programs Corporation *A subsidiary of Camp Dresser & McKee Inc.*		**8/98**

7.2 GROUNDWATER

Analytical results of groundwater samples revealed the presence of several inorganic compounds at concentrations that either exceed the primary or secondary drinking water standards or the State of Tennessee domestic water supply criteria. Aluminum, arsenic, barium, cadmium, chromium, iron, lead, manganese, nickel and vanadium were detected above respective guidance concentrations and/or RGO levels. Lead concentrations in filtered groundwater samples ranged from nondetectable to 770 micrograms per liter (*u*g/l); the EPA action level for lead in groundwater is 15 *u*g/L.

Using only the filtered data set from the May 1997 sampling event, it appears that groundwater lead contamination is limited to an area just east and downgradient of the RM wrecker building. Under this assumption, the horizontal extent of the contaminant plume is about 300 feet by 200 feet. In contrast, using groundwater quality data from all historic unfiltered samples, combined with unfiltered and filtered data from the May 1997 sampling event, it could be interpreted that groundwater contamination is site-wide. In this case, the entire site would be considered a source. Under this assumption, the horizontal extent of the contaminant plume is at least 800 feet by 450 feet and extends off site.

Although EPA Region 4 policy is to use only unfiltered sample results for risk assessment and determining extent of contamination, the difficulty in using the historic unfiltered sample data and even the May 1997 unfiltered sample data is that the turbidity of these samples does not meet EPA Region 4 Standard Operating Procedure goal of less than 10 NTU. The results from the unfiltered samples with high turbidity are not representative of lead concentrations in fully developed water supply wells because water supply wells in regular use do not produce water with high turbidity due to the development of a natural filter pack around the well screen (EPA 1998d). In addition, the results for MW5 presented on Figure 4-3 indicate that recent samples do not confirm earlier sample results. Reported lead concentrations declined from 500 ug/l to 3 ug/l in seven years. This decline is difficult to explain because lead is not degradable and the source has not been removed. The lower levels present in the more recent sampling events suggest that the earlier data may not be valid.

The high turbidity associated with the unfiltered samples collected at the RM site means that the horizontal extent of contamination remains undefined. It may be much less than the current data indicate. Field measurements collected during the 1997 sampling event suggest that measurements with acceptably low turbidity could be attained at this site with longer development periods.

In addition, as indicated in Section 4.0, the vertical extent of groundwater contamination has not been determined since there are no deep wells or cluster wells at the site which could be used to determine the vertical hydraulic gradient. Without this information, vertical extent of contamination cannot be defined. It is important to have an understanding of the vertical extent of contamination to effectively evaluate potential remedial alternatives to use in the remediaiton of the contamination.

7.3 SURFACE WATER

Analytical results of surface water samples revealed concentrations of several inorganic compounds that exceeded background concentrations. Significant inorganic contaminants included antimony, arsenic, cadmium, iron, lead, and manganese.

7.4 HUMAN HEALTH EVALUATION

Using the soil and groundwater data collected during previous investigations at the RM site, a baseline risk assessment was completed as part of this RI.

As a result of the BRA, COCs were defined for soil and groundwater. For the protection of human health, aluminum, antimony, arsenic, barium, cadmium, copper, iron, lead, manganese, selenium, and vanadium were defined as soil COCs. Groundwater COCs include aluminum, arsenic, barium, cadmium, chromium, iron, lead, manganese, nickel, and vanadium. For additional information on the BRA, refer to the BRA report (Section 5.0).

7.5 ECOLOGICAL RISK ASSESSMENT

The ecological risk assessment conducted for the RM site identified wetlands north and east of the facility, as well as the facility itself as areas of concern and evaluated the degree of contamination in wetlands further from the facility that had not been previously evaluated. By using site-specific contaminant concentrations in sediment, water, biological tissue, and toxicity evaluations, the risk assessment determined the potential for ecological risk. The results of the ecological risk assessment concluded that of the metals calculated to pose a potential risk, lead was determined to pose the highest risk to the ecological risk receptors at the site. Specific findings include:

- the levels of antimony, arsenic, cadmium, copper, lead, and mercury in the sediment are sufficient to have an adverse effect on benthic invertebrate community structure and function

- the levels of aluminum, arsenic, cadmium, copper, iron, lead, and zinc are sufficient to have an adverse effect on early life stages of amphibians

- the levels of lead in surface water, sediment, and biota are sufficient to have an adverse effect on insectivorous birds and carnivorous birds

- the levels of aluminum, arsenic, cadmium, lead, and nickel in surface water, sediment, and biota are sufficient to have an adverse effect on herbivorous mammals and insectivorous mammals

- the levels of aluminum, arsenic, cadmium, and lead in surface water, sediment and biota are sufficient to have an adverse effect on carnivorous mammals

For additional information on the ecological risk assessment, refer to the ecological risk assessment report (Appendix L).

7.6 RECOMMENDATIONS

Based on the results of the previous investigations described in the RI report, the following action is recommended:

- The completion of an FS to develop and screen alternative remedial actions to reduce COC concentrations in source soils, including surface and subsurface soils, and groundwater, to levels that are acceptable for the protection of human health and the environment and for the protection of groundwater.

For the protection of human health and ecological receptors, those COCs that are related to past operations at the facility should be considered in the development of a soil/sediment remedial alternative. These COCs include aluminum, antimony, arsenic, barium, cadmium, copper, iron, lead, manganese, selenium, and vanadium. For groundwater, COCs include aluminum, arsenic, barium, cadmium, chromium, iron, lead, manganese, nickel, and vanadium. For ecological receptors, COCs include aluminum, antimony, arsenic, cadmium, copper, iron, lead, mercury, nickel and zinc.

Results from previous investigations suggest that lead will be the "driver" in any remediation effort conducted at the site. The presence of lead is sufficiently widespread that gearing a remediation effort to lead will also remediate other COC contamination, meaning that the extent of lead contamination serves as a good indicator of the extent of all the COC contamination at the RM site. In addition, the ecological risk assessment concluded that of all the metals calculated to pose a potential risk, lead was determined to pose the highest risk to the ecological receptors at the site.

Development of a remedial effort specifically for contaminated surface water is not recommended if the contaminant source is remediated. That is, if groundwater feeding surface water is remediated, and contaminated sediments are removed, surface water would be remediated.

Surface water quality could be monitored to determine the effectiveness of the contaminant source remediation.

Finally, the development and selection of a remedial alternative for groundwater should include a careful consideration of the limits of the modeling efforts conducted in support of the EE/CA and this RI/FS, and the difference in results obtained from each of the modeling runs. While the EE/CA modeling results indicate that various pump and treat scenarios may be effective in remediation of contaminated groundwater at the RM site, the RI/FS modeling results suggest that pump and treat may not be a viable alternative to reduce the maximum lead in water concentration to below the action level of 15 ug/l, due to the length of time (greater than 100 years) required by the alternative. Sufficient uncertainty regarding the modeling exists to leave the possibility that a pump and treat scenario may not effectively remediate contaminated groundwater to RGO levels (e.g. MCLs). Considering the nature of the site contaminants, additional data collection and aquifer testing will be necessary prior to design of any groundwater pump and treat alternative/technology.

8.0 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP) define RAOs that are applicable to all Superfund sites. They relate to the statutory requirements for the development of remedial actions. Site-specific RAOs relate to potential exposure routes and specific contaminated media, such as soil, and are used to identify target areas of remediation and contaminant concentrations. They require an understanding of the contaminants in their respective media and are based upon the evaluation of risk to human health and the environment, protection of groundwater, information gathered during the RI, applicable guidance documents, and federal and state ARARs. RAOs are as specific as possible without unduly limiting the range of alternatives that can be developed for detailed evaluation.

The following subsections present ARARs, COCs and remediation goals for contaminated media, including surface and subsurface soil, waste slag, building ruins, demolition debris, and groundwater, and development of RAOs for the RM site. The estimated extent of contamination above the remediation goals also is presented.

8.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

As required under Section 121 of CERCLA, remedial actions carried out under Section 104 or secured under Section 106 must be protective of human health and the environment and attain the levels or standards of control for hazardous substances, pollutants, or contaminants specified by the ARARs of federal environmental laws and state environmental and facility siting laws, unless waivers are obtained. According to EPA guidance, remedial actions also must take into account nonpromulgated "to be considered" criteria or guidelines if the ARARs do not address a particular situation.

The requirement that ARARs be identified and complied with and the development and implementation of remedial actions is found in Section 121(d)(2) of CERCLA (United States Code [USC] Section 9621(d)(2)). Section 121(d)(2) requires that, for any hazardous substance remaining onsite, all federal and state environmental and facility siting standards, requirements, criteria, or limitations shall be met at the completion of the remedial action to the degree that those requirements are legally applicable or appropriate and relevant under the circumstances present at the site.

The degree to which these environmental and facility siting requirements must be met varies, depending on the applicability of the requirements. Applicable requirements must be met to the full extent required by law. CERCLA provides that permits are not required when a response action is taken “onsite”. The NCP defines the term “onsite” as “the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for the implementation of the response action” (40 Code of Federal Regulations [CFR] 300.5). Although permits are not required, the substance of the applicable permits must be met. On the other hand, only the relevant and appropriate portions of non-applicable requirements must be achieved, and only to the degree that they are substantive rather than administrative in nature.

8.1.1 DEFINITION OF ARARS

A requirement under CERCLA, as amended, may be either “applicable” or “relevant and appropriate” to a site-specific remedial action, but not both. The distinction is critical to understanding the constraints imposed on remedial alternatives by environmental regulations other than CERCLA.

<u>Applicable Requirements</u>

Applicable requirements pertain to those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Applicable requirements are defined in the NCP, at 40 CFR 300.5 -- Definitions.

Relevant and Appropriate Requirements

Relevant and appropriate requirements pertain to those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site per se, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate. Relevant and appropriate requirements are defined in the NCP, at 40 CFR 300.5 -- Definitions.

Other Requirements To Be Considered

These requirements pertain to federal and state criteria, advisories, guidelines, or proposed standards that are not generally enforceable but are advisory and that do not have the status of potential ARARs. Guidance documents or advisories "to be considered" in determining the necessary level of remediation for protection of human health or the environment may be used where no specific ARARs exist for a chemical or situation, or where such ARARs are not sufficient to be protective.

Waivers

Superfund specifies situations under which the ARARs may be waived (40 CFR 300.430: Remedial Investigation/Feasibility Study (f) Selection of Remedy). The situations eligible for waivers include:

- the alternative is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal or state requirement;
- compliance with the requirement will result in greater risk to human health and the environment than other alternatives;
- compliance with the requirement is technically impracticable from an engineering perspective;
- the alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation through use of another method or approach;
- with respect to a state requirement, the state has not consistently applied, or demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances at other remedial actions within the state; or
- for Fund-financed response actions only, an alternative that attains the ARAR will not provide a balance between the need for protection of human health and the environment at the site and the availability of Fund monies to respond to other sites that may present a threat to human health and the environment.

Where remedial actions are selected that do not attain ARARs, the lead agency must publish an explanation in terms of these waivers. It should be noted that the "fund balancing waiver" only applies to Superfund-financed remedial actions.

ARARs apply to actions or conditions located onsite and offsite. Onsite actions implemented under CERCLA are exempt from administrative requirements of federal and state regulations, such as permits, as long as the substantive requirements of the ARARs are met. Offsite actions are subject to the full requirements of the applicable standards or regulations, including all administrative and procedural requirements.

Based on the CERCLA statutory requirements, the remedial actions developed in this FS will be analyzed for compliance with federal and state environmental regulations. This process involves the initial identification of potential requirements, the evaluation of the potential requirements for applicability or relevance and appropriateness, and finally a determination of the ability of the remedial alternatives to achieve the ARARs.

8.1.2 IDENTIFICATION OF ARARS

Three classifications of requirements are defined by EPA in the ARAR determination process.

- Chemical-specific - requirements that set protective remediation goals for the COCs.
- Location-specific - requirements that restrict remedial actions based on the characteristics of the site or its immediate surroundings.
- Action-specific - requirements that set controls or restrictions on the design, implementation, and performance levels of activities related to the management of hazardous substances, pollutants, or contaminants.

Chemical-specific ARARs include those laws and regulations governing the release of materials possessing certain chemical or physical characteristics, or containing specified chemical compounds. Chemical-specific requirements set health- or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, contaminants, and pollutants. These requirements provide protective site remediation levels as a basis for calculating remediation goals for the COCs in the designated media. Examples include drinking water standards and ambient air quality standards. Chemical-specific ARARs can be established once the nature of the contamination at the site has been defined, which is accomplished during the RI phase. Location-specific ARARs are design requirements or activity restrictions based on the geographical or physical positions of the site and its surrounding area. Location-specific requirements set restrictions on the types of remedial activities that can be performed based on site-specific characteristics or location. Examples include areas in a floodplain, a wetland, or a historic site. Location-specific criteria can generally be established early in the RI/FS process since they are not affected by the type of contaminant or the type of remedial action implemented. Location-specific ARARs for soil at the RM site were evaluated and consisted of location standards for work in a floodplain, protection of endangered species, fish and wildlife coordination, archeological and historical preservation, protection of wetlands, and guidelines for dredged or fill material placement. Location-specific ARARs should be re-evaluated during the design phase.

Action-specific ARARs are technology-based, establishing performance, design, or other similar action-specific controls or regulations for the activities related to the management of hazardous substances or pollutants. Action-specific requirements are triggered by the particular remedial action alternatives that are selected to accomplish the cleanup of hazardous wastes. An example includes Resource Conservation and Recovery Act (RCRA) incineration regulations. Federal and state ARARs for the RM site are listed in **Tables 8-1 and 8-2**.

8.2 CONTAMINANTS OF CONCERN AND REMEDIAL GOAL OPTIONS

Various environmental media, including surface soil, subsurface soil, sediment, groundwater, surface water, building material, and waste material were sampled from onsite and offsite areas during the site investigations conducted at the RM site. The samples were primarily analyzed for TAL metals, however, a limited number of samples also were analyzed for VOCs, BNAs, and pesticide/PCBs. Based on the results of the BRA, COCs and general RGOs were developed for the protection of human health for affected media at the RM site.

TABLE 8-1

SUMMARY OF POTENTIAL FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS ROSS METALS SITE

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
Contaminant-Specific			
Clean Air Act	42 USC § 7409		
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Air quality levels that protect public health	Applicable
Resource Conservation and Recovery Act			
Identification and Listing of Hazardous Waste	40 CFR Parts 262-265 and Parts 124, 270, and 271	Defines those solid mining-related wastes that are subject to regulation as hazardous wastes under 40 CFR Parts 262-265, 124, 270, and 271	Applicable
Clean Water Act	33 USC § 1251-1376		
Water Quality Criteria	40 CFR Part 131 Quality Criteria for Water 1976, 1980, 1986	Sets criteria for water quality based on toxicity to aquatic organisms and human health	Relevant and Appropriate
NPDES	40 CFR Part 122	General permits for discharge from construction	Relevant and Appropriate
Dredge and Fill Requirents [Section 404(b)(1)]	40 CFR Part 230	Action to prohibit discharge of dredged or fill material into wetland without permit.	Relevant and Approrpriate
Safe Drinking Water Act	40 USC § 300		
National Primary Drinking Water Standards	40 CFR Part 141	Establishes health-based standards for public water systems (maximum contaminant levels)	Relevant and Appropriate
National Secondary Drinking Water Standards	40 CFR Part 143	Establishes welfare-based standards for public water systems (secondary maximum contaminant levels)	Relevant and Appropriate

TABLE 8-1 (Continued)

SUMMARY OF POTENTIAL FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
ROSS METALS SITE

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
Location-Specific			
National Historic Preservation Act	16 USC § 470; 36 CFR Part 800	Requires federal agencies to take into account the effect of any federally-assisted undertaking or licensing on any district, site, building, structure, or object that is included in, or eligible for, inclusion in the National Register of Historic Places.	Applicable
Archeological and Historic Preservation Act	16 USC § 469; 40 CFR § 6.301(c)	Establishes procedures to preserve historical and archeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program.	Applicable
Floodplain Management Executive Order	Executive Order 11988	Action to avoid adverse effects, minmize potential harm, and restore and preserve natural and beneficial values of the floodplain.	Applicable
Wetlands Management Executive Order	Executive Order 11990	Action to minimize the destruction, loss or degradation of wetlands.	Applicable
Protection of Wetlands and Floodplains	40 CFR Part 6, Appendix A	Contains EPA's regulations for implementing Executive Orders 11988 and 11990.	Applicable
Groundwater Classification	EPA Groundwater Protection Strategy	Through process of classification, groundwater resources are separated into catergories on the basis of their value to society, use, and vulnerability to contamination. Groundwater classes factor into deciding the level of protection or remediation the resource will be provided.	To Be Considered

TABLE 8-1 (Continued)

**SUMMARY OF POTENTIAL FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
ROSS METALS SITE**

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
Historic Sites, Buildings and Antiquities Act	16 USC §§ 461-467; 40 CFR § 6.301(a)	Requires federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks	Applicable
Endangered Species Act	16 USC §§ 1531; 40 CFR Part 6.302; 50 CFR Part 402	Requires action to conserve endangered species within critical habitat upon which species depend; includes consultation with the Department of the Interior	Applicable
Fish and Wildlife Coordination Act	16 USC §§ 661-666c	Any federal agency which proposes or authorizes a modification to a stream, or water body which may affect fish and wildlife must consult with the Fish and Wildlife Service. This act requires protection of fish and wildlife resources.	Applicable
Migratory Bird Treaty Act of 1973	16 USC §§ 703	Established a prohibition, unless permitted, to pursue, hunt, capture, kill, or take any migratory bird or attempt any of these actions. Also protects migratory birds in their environments.	Applicable
Emergency Wetlands Resources Act of 1986		Requires the Secretary to establish a National Wetlands Priority Plan and report to Congress on the loss of wetlands including the role federal agencies have in the loss of these wetlands.	Applicable
U.S. Fish and Wildlife Service Mitigation Policy		Provides for the policy to develop consistent and effective recommendations to protect and conserve natural resources. Also allows federal and private developers to incorporate mitigation measures into the early stages of planning.	Applicable

TABLE 8-1 (Continued)

SUMMARY OF POTENTIAL FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
ROSS METALS SITE

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
National Environmental Policy Act of 1969		Requires federal agencies to prepare comprehensive environmental impact statements for every recommendation on proposals for legislation and federal actions which might significantly affect the quality of the environment.	Applicable
Resource Conservation and Recovery Act	40 CFR Part 264	Requires hazardous waste facilities to be (1) located at least 200 feet from a fault and (2) designed to withstand a 100-year flood if located in the 100-year flood plain.	Applicable
Action-Specific			
Hazardous Materials Transportation Act	49 USC §§ 1801-1813		
Hazardous Materials Transportation Regulations	49 CFR Parts 10, 171-177	Regulates transportation of hazardous materials, including mining wastes that are not exempt under the Bevill Amendment	Applicable

TABLE 8-1 (Continued)

SUMMARY OF POTENTIAL FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
ROSS METALS SITE

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
Resource Conservation and Recovery Act			
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR Part 257	Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment and thereby constitute prohibited open dumps	Relevant and Appropriate
Standards Applicable to Transporters of Hazardous Waste	40 CFR Part 263	Establishes standards that apply to persons transporting hazardous waste within the U.S. if the transportation requires a manifest under 40 CFR Part 262	Applicable
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR Part 264	Establishes minimum national standards which define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste	Relevant and Appropriate
Clean Water Act	33 USC § 1342		
NPDES	40 CFR Part 122	Requires permits for the discharge of pollutants from any point source into waters of the United States	Relevant and Appropriate
Dredge and Fill Requirents [Section 404(b)(1)]	40 CFR Part 230	Action to prohibit discharge of dredged or fill material into wetland without permit.	Relevant and Appropriate
Occupational Safety and Health Administration Requirements	29 CFR 1910	Establishes requirements for workers at remedial action sites. Any remedial action on-site must be performed in accordance with applicable OSHA standards.	Applicable

TABLE 8-2

SUMMARY OF POTENTIAL STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS ROSS METALS SITE

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable Relevant and Appropriate
		Contaminant-Specific	
<u>Air Quality Act</u>	TCA 68-201	Establishes Tennessee's air quality standards necessary for protectiveness of the public health and welfare	Applicable
National primary and secondary air quality standards	1200-3-3	Air quality standards protective of the public health	Applicable
Fugitive Dust	1200-3-8	Regulates fugitive dust emissions by requiring the operator to prevent particulate matter from becoming airborne from handling, transporting, or storing any materials	Applicable
<u>Water Quality Act</u>	TCA 69-3-101	Declares that the people of Tennessee have the right to unpolluted waters and to abate existing pollution of waters, reclaim polluted waters, prevent future pollution of waters, and to plan for their future beneficial use	Applicable
General Water Quality Criteria and Antidegradation Statement	1200-4-3	These regulations specify the permissible conditions of waters with respect to pollution.	Applicable
Use Classification of Surface Waters	1200-4-4	Specifies preventative or corrective measures required to control pollution in various waters or in different sections of the same waters	Applicable
<u>Solid Waste Disposal Act</u>	TCA 68-211 1200-1-7-.01 Appendix 1	Specifies the maximum contaminant limits for groundwater contaminants	Applicable

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable Relevant and Appropriate
Location -Specific			
Solid Waste Processing and Disposal	1200-1-7-.04	Disposal facilities must not be located in a 100-yr floodplain unless it is demonstrated to the satisfaction of the Commissioner that: 1) location in a floodplain will not restrict the flow of the 100-year flood nor reduce the temporary water storage capacity of the floodplain. 2) the facility is designed, constructed, operated, and maintained to prevent washout of any solid waste. New landfills and lateral expansions shall not be located in wetlands unless the owener or operator can demonstratethe following: 1) a rebuttal to presumption of a practical alternative that does not involve wetlands. 2) construction and operation of landfill will not cause or contribute to violations of applicable State water quality standards, or toxic effluent standard or prohibition under Section 307 of the CWA, a taking of any threatened or endangered species, or a destruction or adverse modification of critical habitat for threatened or endangered species. 3) the landfill will not cause or contribute to significant degradation of wetlands. 4) to the extent required by the CWA or TWQCA, steps have been taken to attempt to achieve no net loss of wetlands. 5) sufficient information is available to make a reasonable determination with respect to these demonstrations.	Applicable

TABLE 8-2 (Continued)

SUMMARY OF POTENTIAL STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS ROSS METALS SITE

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable Relevant and Appropriate
		Action-Specific	
Solid Waste Disposal Act	TCA 68-211	Establishes specific requirements for the operation and maintenance of solid waste landfill disposal sites.	Applicable
Solid Waste Management Regulations	1200-1-7	Specifies the performance standards that must be met by Class I, II, III, and IV disposal facilities; standards include engineering controls to (1) minimize the potential for release of constituents, (2) minimize the attraction and propagation of birds, (3) control access and use, (4) construct runon and runoff controls, and (5) minimize the potential for collapse in karst terrains. Other standards that may apply include the selection of the remedy according to long- and short-term effectiveness and protection, leachate migration control, liner designs, and general performance standards for closure and post-closure care. Groundwater monitoring requirements applicable to the selected remedy will be addressed separately.	
Hazardous Waste Management Act	TCA 68-212-105	Prohibits placing or depositing any hazardous waste into the waters of the state, except in a manner approved by the Tennessee Water Quality Control Board.	Relevant and Appropriate
	TCA 68-212-108	No person shall construct, substantially alter or own, or operate a hazardous waste treatment, storage, or disposal facility, nor treat, store, or dispose of a hazardous waste: nor shall any hazardous waste transporter receive a hazardous waste from, or deliver a hazardous waste to, any location in the state without obtaining a permit for such facility or activity.	Relevant and Appropriate
Hazardous Waste Management Regulations	1200-1-11	Establishes the minimum standards that define the acceptable management of hazardous waste; incorporates by reference federal regulations governing the overall hazardous waste management system, including design and operating standards, management of hazardous wastes, and land disposal restrictions. State regulations substantially parallel the federal law.	Applicable, Relevant and Appropriate

TABLE 8-2 (Continued)

SUMMARY OF POTENTIAL STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS ROSS METALS SITE

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable Relevant and Appropriate
Air Quality Act	TCA 68-201-101	The purpose is to achieve and maintain levels of air quality that are protective of the public health and welfare.	Applicable
Tennessee Air Pollution Control Regulations	1200-3-6 and 1200-3-8	Sets nonprocess emission standards where one or more sources emit particulates at rates exceeding the ambient air quality standard for particulate matter; regulates fugitive dust emissions by requiring the operator to prevent particulate matter from becoming airborne from handling, transporting, or storing any materials	Applicable
Safe Drinking Water Act	TCA 68-221-711	Prohibits discharge by any person of sewage or other waste at such location as will or will likely come in contact with the public water system intake.	Relevant and Appropriate
Tennessee Water Quality Control Act	TCA 69-3-101	For remedial actions at the Ross Metals Site involving construction, demolition, and excavations in contaminated soils, engineering controls must be implemented to prevent discharges that may affect the water quality of nearby surface waters.	Relevant and Appropriate
	TCA 69-3-114	It is unlawful to discharge any substances into the waters of the state that violate water quality standards established by the Water Quality Board.	Relevant and Appropriate

TABLE 8-2 (Continued)

SUMMARY OF POTENTIAL STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
ROSS METALS SITE

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable Relevant and Appropriate
Tennessee Clean Water Act	TCA 69-3-108	Requirements for general permits for storm water discharges from construction activities.	Relevant and Appropriate
Water Quality Regulations	1200-4-6	These regulations classify a well as any bored, driven, or dug shaft or hole whose depth is greater than the largest surface dimension. Furthermore, no permit or authorization is allowed where an injection well causes or allows movement of fluid containing any contaminant that would result in groundwater pollution.	Relevant and Appropriate
	1200-4-7-.07	Construction activities during the selected remedial action may also result in modifying certain drainage patterns for storm water from the site. Tennessee regulations found in the rule address the alteration of wet-weather conveyances and require that waters designated as wet-weather conveyances shall be protective of wildlife and humans that may come in contact with them and maintain standards applicable to all downstream waters.	Relevant and Appropriate
	1200-4-10	These regulations substantially mirror federal laws with respect to issuing general NPDES permits for storm water discharges associated with construction activities. The regulations address discharges of storm water runoff from land disturbed by construction activity, including clearing, grading, and excavation, except operations that result in disturbing less than 5 acres of total land area that are not part of a larger, common plan of development or sale.	Relevant and Appropriate

TABLE 8-2 (Continued)

SUMMARY OF POTENTIAL STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS ROSS METALS SITE

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable Relevant and Appropriate
State To-Be-Considered Guidance			
Hazardous Waste Management		Remedial actions involving soil excavations require adherence to state and federal soil cleanup standards established for contaminants of concern at the site. Tennessee has not published such standards under promulgated law; however, Tennessee established soil remediation guidance levels consistent with those specified under the Environmental Protection Agency's RCRA Facility Investigation Guidance document. These standards are to-be-considered guidance levels that may be applicable to the selected remedial alternative.	Applicable

Notes:

CFR	Code of Federal Regulations
NPDES	National Pollutant Discharge Elimination System
TCA	Tennessee Code Annotated
USC	United Stated Code

RGOs provide remedial planning staff with long-term targets to use during analysis and selection of remedial action alternatives. Ideally, such goals, if achieved, will comply with ARARs and result in residual risks that fully satisfy the NCP requirements for the protection of human health and the environment.

Risk-based RGOs are guidelines and do not establish that cleanup to meet these goals is warranted. Risk-based RGOs were calculated for both cancer and non-cancer effects for the COCs in contaminated media at the RM site. **Table 8-3** presents the risk-based (human health) RGOs for surface soil and groundwater.

In addition to the BRA-based RGOs, a soil RGO for lead was calculated based on the potential for lead to migrate to, and contaminate, groundwater. As part of the EE/CA, a one dimensional geochemical model was used to evaluate (1) the migration of lead in soil below the smelter slag, (2) the migration of lead below the contaminated soil near the wrecker building, and (3) a subsurface soil removal action level. For the smelter slag, model output predicted that lead will migrate to groundwater in six years and that groundwater lead concentration will exceed 15 ug/l in 55 years, suggesting that the slag material is a potential source of contamination to groundwater. In addition, model output suggest that soils near the wrecker building are acting as a continuing source of contamination to groundwater and that lead concentration will continue to increase unless the source is removed.

As indicated, the geochemical model also was used to estimate the concentration of lead in subsurface soil that would result in a groundwater concentration below 15 ug/l. Model output indicated that removal of lead to 100 mg/kg left a residual soil lead concentration of 31.71 mg/kg, which is near background levels, and predicts that a removal action level of 100 mg/kg would be protective of groundwater for at least 90 years. **Appendix K** presents the results of the modeling performed for the site. However, the conservative nature of this number, along with the uncertainty surrounding the modeling effort, make it inappropriate to use as a subsurface soil cleanup goal.

Table 8-3
Human Health Risk-based Remedial Goal Options for Surface Soil and Groundwater
Ross Metals Site
Rossville, Tennessee

Contaminant of Concern	**Remedial Goal Option (in mg/kg)**		
Protection of Human Health (Surface Soil) (mg/kg)	Residential Land Use		
	1E-6 or HQ=0.1	1E-5 or HQ=1	1E-4 or HQ=3
Aluminum	7,335	73,355	220,064
Antimony	3	29	88
Arsenic	2	23	69
Barium	505	5,047	15,141
Cadmium	1,403 or 7	14,032 or 73	140,323 or 220
Copper	293	2,934	8,803
Iron	2,201	22,006	66,019
Lead	400(1)	NA	NA
Manganese	437	4,374	13,122
Selenium	37	367	1,100
Vanadium	51	513	1,540
Protection of Human Health (Groundwater)(ug/l)			
Aluminum (Secondary MCL = 200)	1,564	15,643	46,929
Arsenic (Secondary MCL = 50)	0.5	5	14
Barium (MCL = 2,000)	110	1,095	3,285
Cadmium (MCL = 5)	1	8	23
Chromium (MCL = 100)	8	78	235
Iron (Secondary MCL = 300)	469	4,693	14,079
Lead (Action Level = 15)	NA	NA	NA
Manganese (Secondary MCL = 50)	110	1,095	3,285
Nickel (MCL = 100)	31	313	939
Vanadium	11	110	329

(1) Remediation goal based on EPA's Integrated Uptake Biokinetic model for lead, protective of children, ages 1 - 7.

The 100 mg/kg goal is based on the assumption of a 5000 mg/kg surface load factor. However, the establishment of a 400 mg/kg risk-based surface soil clean-up goal would mean surface soil concentrations no greater than 400 mg/kg. With a surface soil concentration of 400 mg/kg and considering the nature of the contamination, clean up of subsurface soils to 400 mg/kg in the area of the wrecker building and truck wash should allow for the protection of groundwater.

Finally, as a result of an ecological risk assessment conducted for the wetlands adjacent to the site, a range of RGOs for ecological COCs were developed based on the protection of ecological receptors. The most conservative of these are presented in **Table 8-4**. These values were obtained by using mean percent moisture concentration (33%) for samples collected from the most contaminated areas of the wetlands to convert NOAEL/LOAEL ranges (wet weight basis) to a dry weight RGO range.

By considering the most conservative of the surface soil risk-based RGOs, risk-based groundwater RGOs and MCLs, the modeling-derived subsurface soil RGO for the protection of groundwater, the wetlands sediment RGO for the protection of ecological receptors, as well as background concentrations, a list of RGOS applicable to the RM site can be developed. **Table 8-5** presents a summary of RGOs for the RM site. Note that for ecological receptors, a range of RGO concentrations is presented. For an effective remediation, an evaluation of which level within the range provides the greatest benefit with the least disturbance to the wetlands must be made. Refer to Section 8.4.2 for additional information.

8.3 REMEDIAL ACTION OBJECTIVES

In consideration of the COCs and RGOs, the recommended RAOs for the RM site are as follows:

Soil

- prevent ingestion, inhalation, or direct contact with surface soil that contain concentrations in excess of the RGOs;

Table 8-4
Ecological Risk-Based Remedial Goal Options For Wetland Sediments
Ross Metals Site
Rossville, Tennessee

Contaminant of Concern	**Remedial Goal Option (Range)**	**Basis**
Wetland Sediment (mg/kg dry weight)		
Aluminum	79.6 - 796	NOAEL/LOAEL Endpoint: Carnivorous Mammals
Antimony	28.4 - 104	NOAEL/LOAEL Endpoint: Benthic Invertebrates
Arsenic	0.21 - 2.08	NOAEL/LOAEL Endpoint: Carnivorous Mammals
Cadmium	0.37 - 3.73	NOAEL/LOAEL Endpoint: Herbivorous Mammals
Copper	10.2 - 101.5	NOAEL/LOAEL Endpoint: Benthic Invertebrates
Lead	192.5 - 1925	NOAEL/LOAEL Endpoint: Insectivorous Mammals
Mercury	ND - 0.21	NOAEL/LOAEL Endpoint: Benthic Invertebrates
Nickel	2.1	NOAEL Endpoint: Benthic Invertebrates

ND - Not Detected

Table 8-5
Potential Remedial Goal Option Levels
Ross Metals Site
Rossville, Tennessee

Contaminant of Concern	Remedial Goal Option	Basis
Surface Soil (mg/kg)		
Aluminum	11,620	Avg. Background Concentration
Antimony	3	Hazard Quotient Level = 0.1
Arsenic	5	Avg. Background Concentration
Barium	505	Hazard Quotient Level = 0.1
Cadmium	7	Hazard Quotient Level = 0.1
Copper	293	Hazard Quotient Level = 0.1
Iron	16,100	Avg. Background Concentration
Lead	400	Protection of Human Health
Manganese	559	Avg. Background Concentration
Selenium	37	Hazard Quotient Level = 0.1
Vanadium	51	Hazard Quotient Level = 0.1
Subsurface Soil (mg/kg)		
Lead	400	Protection of groundwater
Wetlands Sediment (mg/kg)		
Aluminum	8,860	Avg. Background Concentration
Antimony	28.4 - 104	Protection of Ecological Receptors
Arsenic	5.58	Avg. Background Concentration
Cadmium	0.37 - 3.73	Protection of Ecological Receptors
Copper	22.4 - 101.5	Protection of Ecological Receptors
Lead	192 - 1,925	Protection of Ecological Receptors
Mercury	ND - 0.21	Protection of Ecological Receptors
Nickel	9.10	Avg. Background Concentration
Groundwater (ug/l)		
Aluminum (Secondary MCL = 200)	200	Secondary MCL
Arsenic (Secondary MCL = 50)	50	Secondary MCL
Barium (MCL = 2,000)	2000	MCL
Cadmium (MCL = 5)	5	MCL
Chromium (MCL = 100)	100	MCL
Iron (Secondary MCL = 300)	300	MCL
Lead (Action Level = 15)	15	Action Level
Manganese (Secondary MCL = 50)	50	Secondary MCL
Nickel (MCL = 100)	100	MCL
Vanadium	11	Hazard Quotient Level = 0.1

ND - Not Detected

- control migration and leaching of contaminants in surface and subsurface soil to groundwater that could result in groundwater contamination in excess of MCLs;

- control migration of contaminants in surface soil/sediment to surface water that could result in groundwater contamination in excess of MCLs;

- prevent ingestion or inhalation of soil particulates in air that contain concentrations in excess of the RGOs;

- control future releases of contaminants to ensure protection of human health and the environment.

Wetlands

- Reduce potential for exposure of contaminated sediments/soils and surface waters to ecological receptors,

- prevent transport and migration of site contaminants to the adjacent uncontaminated wetlands and the Wolf River,

- restore impacted wetland communities, and

- prevent further degradation of the wetlands and the adjacent areas.

Groundwater

- prevent ingestion of groundwater having concentrations in excess of remediation goals;

- restore the groundwater aquifer system by cleanup to the remediation goals, and prevent the migration of the pollutants beyond the existing limits of the known contaminant plume or established point of compliance;

- prevent discharge of groundwater contaminants to surface water bodies that would exceed surface water quality standards;

- control future releases of contaminants of concern in groundwater to ensure protection of human health and the environment; and

- permanently or significantly reduce the M/T/V of characteristic principal-threat hazardous waste with treatment.

8.4 EXTENT OF CONTAMINATION ABOVE REMEDIAL GOAL OPTIONS

The designated study area for the EE/CA focused on the fenced area surrounding the main processing buildings and the unlined landfill located north of the fence. The designated study area for the ecological investigations conducted as part of the ecological risk assessment focused on contamination north and northeast of the facility and landfill. The area contained within the fenced property boundaries and the landfill covers about 8 acres. To facilitate the evaluation of potentially applicable removal action alternatives for the site, solid media waste can be divided into four general categories based on physical and chemical characteristics:

- Waste slag (landfilled and stockpiled on site)
- Contaminated soil (in old fenced area and landfill area)
- Building ruins
- Demolition debris (pavement)
- Contaminated sediment (in wetlands)

Although both the BRA and the ecological risk assessment identify several inorganic COCs in addition to lead, the estimate of contaminated solid media is based on the extent of lead contamination. Site investigation results suggest a widespread presence of lead at substantial concentrations; indicating the cleanup of lead contamination would be the effective driver of a remedial effort. This indicates that a determination of the volume of contaminated solid media based on lead contamination would also cover other COC contamination. In addition, the ecological risk assessment suggests that lead poses the highest risk to ecological receptors. Therefore, estimates of contaminated media are based on the presence of lead.

8.4.1 CONTAMINATED SOLID MEDIA IN OLD FENCED AREA AND LANDFILL

Based on excavations performed in the landfill at the north end of the site in November 1996, an estimated 10,000 CY of buried landfill slag is present on site. In addition, several stockpiles of waste slag are located in various on-site buildings (see Figure 2-2). The building labeled "furnace and raw materials refinery" contains two waste slag stockpiles totaling about 700 CY. The buildings labeled "wrecker," "slag fixation," and "shipment" contain waste slag stockpiles of about 2,600; 700; and 2,000 CY, respectively. The total combined volume of the stockpiled waste slag is about 6,000 CY.

Lead-contaminated surface and subsurface soil is present in the landfill at depths of up to 5.5 feet bgs. Lead-contaminated surface soil is present throughout the fenced portion of the site at depths of up to 1.5 feet beneath the pavement. Based on an area of 450 by 525 feet, the volume of waste soil is estimated as 13,125 CY.

Lead-contaminated subsurface soil was noted along the eastern edge of the wrecker building at depths up to 40 inches bgs. Lead-contaminated subsurface soil was also noted near the southeastern corner of the truck wash. Based on two 125-ft-square areas at depths from 1.5 to 3 feet, the volume of contaminated subsurface soil is estimated as 2,500 CY. Figures 7-1 and 7-2 indicate the extent of lead contamination in site soils.

The deteriorating buildings are located within the fenced portion of the site. The largest of the buildings is a sheet metal building labeled "furnace and raw materials refinery;" the building is roughly 25 to 30 feet high, 180 feet long, and 100 feet wide. After demolition and compaction, the combined volume of the building debris is not expected to exceed 27,000 cubic feet (CF) (1,000 CY). The buildings are in poor condition and constitute a safety hazard.

Additional demolition debris may be generated at the site depending on the remedial action selected. About 20,000 square yards (SY) of asphalt and concrete pavement are located within the fenced portion of the site. An 8-inch-thick concrete pad located within the landfill area covers about 1,333 SY. Therefore, the total area of pavement at the site is about 21,333 SY (including asphalt and concrete). The volume of concrete and asphalt estimated for disposal is 3,700 CY.

Based on the estimated volumes of the landfilled and stockpiled slag, the total volume of slag is estimated to be about 16,000 CY.

8.4.2 CONTAMINATED SEDIMENT IN WETLANDS

In December 1997, EPA ERTC conducted sediment sampling to determine the extent of lead contamination in the wetland area adjacent to the old fenced area and landfill. Samples were collected from 0 to 6 inches in depth and analyzed at the site by field portable X-ray fluorescence (XRF) to determine the extent of lead contamination above. Because RGOs based on protection of ecological receptors are presented as ranges, an acceptable goal within the range must be selected in order to calculate the volume of contaminated sediment in the wetlands. Because lead, as previously indicated, is so widespread and presents the highest risk to ecological receptors; a cleanup goal established for it that takes into account impact to wetlands, should also ensure cleanup of other COCs to acceptable levels.   To determine an acceptable goal, a chart plotting cleanup goals versus area of wetlands to be excavated to obtain the cleanup goal was created and is shown in **Figure 8-1**. Figure 8-1 suggests that 800 mg/kg would be the most effective cleanup goal causing the least disturbance to the wetlands.   Based on the XRF results, there are approximately 5.7 acres of material contaminated above 800 mg/kg lead. **Figure 8-2** illustrates the contaminated wetlands.

8.4.3 SUMMARY OF CONTAMINATED SOLID MEDIA

The total estimated volume of contaminated solid media includes the following components:

fig 8-1

fig 8-2

- Waste Slag

  Landfill: 10,000 CY

  Surface Slag: 6,000 CY

- Lead-contaminated Surface Soil (volume includes areas contaminated with other COCs)

Wetlands (sediment):	9,300 CY (at 800 ppm level)
Old Facility Fenced Area:	13,125 CY (at 400 ppm level)
Landfill Area:	8,750 CY (at 400 ppm level)

- Lead-contaminated Subsurface Soil

  2,500 CY (at 400 ppm level)

- Lead-contaminated Buildings

  1,000 CY (at 10 ug/dl level)

- Demolition Debris

  3,700 CY

The contaminated solid media at the RM site can be considered source material because it includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to groundwater, to surface water, to air, or acts as a source for direct exposure. Because the contaminated solid media is considered source material, the concept of principal threat and low level threat wastes should be applied to the RM site.

Principal threat wastes are those source materials considered to be highly toxic or highly mobile that cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. Although no "threshold level" of risk has been established to identify principal threat waste, source materials with toxicity and mobility characteristics that pose a potential risk several orders of magnitude greater than the acceptable risk level for current or future land use can be considered principal threat wastes. For the RM site, this would conservatively encompass solid media with lead concentrations ranging from 40,000 ppm, since the RGO for lead is 400 ppm in soil, and wetland sediment with lead concentrations ranging from 1,900 mg/kg upward since chronic risk occurs at the LOAEL which is equal to 1,920 mg/kg.

Low level threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of a release. They include source materials that exhibit low toxicity, low mobility in the environment, or are near health-based levels.

The identification of principal threat and low level threat wastes is important because their presence influences the development of appropriate remedial alternatives. Although exceptions apply, EPA generally expects to use treatment to address the principal threats posed by a site, wherever practicable. On the other hand, the use of institutional controls, such as containment, is expected for wastes that pose a relatively low long-term threat or where treatment is impracticable (EPA 1991).

A review of the sampling results presented on Figure 4-2 suggests that some of the contaminated solid media present at the RM site can be considered principal threat waste based on the lead concentrations present. Waste sample SL-01 and site surface soil samples T4-LF/B12, 008SLA, and 013SLA all had lead concentrations greater than 40,000 ppm. In addition, the soil associated with sample 020SLA could be considered principal threat waste based on an arsenic concentration of 40 ppm. Figure 4-4 shows that none of the ecological investigation samples exceeded 80,000 ppm lead.

Assuming an excavation depth of 1.5 ft bgs with a 50 foot x 50 foot excavation grid centered on each of the site soil samples exceeding 40,000 ppm lead, and each of the wetland sediment samples exceeding 1,900 ppm lead, results in a volume of approximately 600 CY of contaminated soil and 8,200 CY of wetland sediment. Adding the 6,000 CY of stockpiled slag to this volume (based on the results of waste sample WS-01), and the 10,000 CY of landfilled slag (based on similarity to the stockpiled slag) results in a total volume of approximately 24,800 CY of the 53,275 CY of total contaminated solid media that could be considered principal threat waste.

8.4.4 GROUNDWATER CONTAMINATION

As indicated in Section 4.4, the extent of groundwater lead contamination is limited to an area just east and downgradient of the RM Wrecker building when considering only the filtered data set from the May 1997 sampling event. This suggests that the horizontal extent of the contaminant plume is about 300 feet by 200 feet. However, when data from all historic unfiltered samples, combined with the May 1997 filtered and unfiltered data, are considered, it appears that groundwater contamination is site wide. Under this assumption, the horizontal extent of the plume is at least 800 by 450 feet and extends beyond the old fenced area and landfill.

The vertical extent of groundwater contamination has not been determined as monitor wells at the site generally terminate at 20 to 30 feet bgs. However, the groundwater modeling conducted as part of the EE/CA assumes the contaminated thickness of the aquifer is equal to 40 feet.

Contaminated groundwater is generally not considered to be a source material. The NCP established a different expectation for remediating contaminated groundwater (i.e., to return useable groundwater to beneficial use in a timeframe that is reasonable given the site characteristics (EPA 1991). Generally, this means that MCLs or risk-based RGOs should be considered in developing remedial alternatives for groundwater. However, under limited circumstances specified in CERCLA 121(d)(2)(B)(ii), alternate concentration limits (ACLs) may be established in lieu of cleanup levels that would otherwise be ARARs (e.g., MCLs).

ACLs may be considered where contaminated groundwater discharges to surface water and such discharge does not lead to statistically significant increases of contaminants in the surface water, and where enforceable measures can be implemented to prevent human consumption of the contaminated groundwater. Generally, ACLs may be used where these conditions are satisfied and where restoration of the groundwater is found to be impracticable, based on a balancing of the remedy selection criteria (see Section 10.0). Based on the results of the groundwater modeling completed for the EE/CA, it is anticipated that ACLs will not be applicable to the RM site since elevated levels of lead in surface water samples collected north and east of the site may at least be partly attributed to groundwater discharge, and a restoration of groundwater at the RM site is not anticipated to be impracticable. However, as section 7.0 indicates, sufficient uncertainty regarding the modeling exists to suggest that it may not be possible to effectively remediate the plume. Should additional data collection efforts and modeling indicate that remediation of the plume is not technically practicable, the development of ACLs for the RM site will need to be considered.

9.0 IDENTIFICATION, SCREENING, AND EVALUATION OF TECHNOLOGIES AND PROCESS OPTIONS

This section presents the identification and screening of technology types and process options applicable for remediation of contaminated media at the RM site using the available site information. The areas to be addressed through contaminated soil/sediment remediation, other solid media remediation, and groundwater remediation (discussed in Section 8.3) were considered though the development of applicable technologies. Potential technologies and process options for contaminated media were identified and screened to eliminate infeasible or impractical options.

General Response Actions (GRAs) for remediation include various containment, removal, treatment (in situ, ex situ, and offsite), and disposal options. Technologies within these categories have been considered for the COCs in contaminated media at the RM site. A preliminary screening of technologies was conducted on the basis of technical implementability which reduced the universe of potentially applicable technologies. Those technologies that can be technically implemented were further evaluated on the basis of effectiveness, implementability, and cost. Those technologies retained for remediation at the site were combined to form remedial action alternatives, presented in Section 10.0 and analyzed in detail in Section 11.0.

9.1 GENERAL RESPONSE ACTIONS

Based on the established RAOs, site conditions, waste characteristics, volume of contaminated media requiring remediation, the presence of principal-threat wastes, the existence of guidance identifying the presumptive remedy for metals in soils, selection of control technologies for remediation of lead battery recycling sites, and technology alternatives for the remediation of soils contaminated with arsenic, cadmium, chromium, lead, and mercury; GRAs were identified. GRAs are those actions that singly or in combination, satisfy the RAOs for the identified media by reducing the concentration of hazardous substances or reducing the likelihood of contact with hazardous substances. The GRAs appropriate for addressing contamination at the RM site include:

- no action,
- institutional controls,
- containment,
- removal/extraction,
- treatment, and
- disposal/discharge.

Each GRA was further investigated and screened for specific technologies and process options.

No Action. The no action response is identified for the purposes of establishing a baseline against which other GRAs are compared. There would not be any preventive or remedial action implemented as a result of the no action response, and the current contamination at the site would continue unabated. However, in accordance with CERCLA Section 121(c), a review/ reassessment of the conditions at the site is required at 5-year intervals to determine if other remedial action efforts are warranted.

Institutional Controls. Institutional controls are limited actions implemented to reduce the potential for human exposure to contaminants. Institutional controls may be physical, such as fences, barriers, or warning signs; or legal, including relocation, zoning, security-restricted access, deed restrictions or notices upon resale or transfer of title, and notices given to current or prospective owners or renters. Extended monitoring is also considered an institutional control. Like the no-action response, these actions would not reduce contaminant concentrations or protect environmental receptors. The contamination at the site would continue unabated.

Institutional actions may be appropriate at sites where there is a high rate of natural attenuation of biodegradable contaminants; if the contaminants are immobile; if the future use risk assessment scenario does not identify them as a potential future hazard; or when the benefits of cleanup are far outweighed by the cost to implement a remedial action. Institutional controls may be an appropriate response when used in conjunction with other remedial measures.

<u>Containment</u>. Containment consists of the construction of physical barriers to prevent human contact with contaminated material and to limit adverse effects on the environment. Common containment options include capping of contaminated areas and construction of slurry walls. Containment is used to isolate the contaminated media and to restrict migration of the contaminants via soil, water, or air pathways. It does not reduce the concentration or volume of contaminants. Containment is the presumptive remedy for low-level threat metals-in-soil wastes.

<u>Removal/Extraction</u>. Removal involves the physical removal of contaminated media from a site. As a result of such a removal, the area is no longer contaminated (as confirmed by testing of soil and/or groundwater) and may be restored to use. Removal generally refers to the excavation of solid media, such as soil or solid/bulk waste. It is usually used in conjunction with other technologies, such as treatment or disposal options, to achieve the RAOs for the removed media. The removal response action does not reduce the concentrations of contaminants in the affected media. It merely transfers the contaminants to be dealt with under another response action.

<u>Treatment</u>. Treatment involves the destruction of contaminants in the affected media; transfer of contaminants from one media to another; or alteration of the contaminants thus making them innocuous. The result is a reduction in M/T/V of the waste. Treatment technologies vary between environmental media and can consist of chemical, physical, thermal, and biological processes. Treatment can occur in place or above ground. This GRA is usually preferred unless site- or contaminant-specific characteristics make it infeasible from an engineering or implementation sense, or too costly. EPA expects to use treatment to address the principal threats posed by a site, wherever practicable. The presumptive remedy for principal threat metals-in-soils wastes involve either reclamation/recovery, which is preferred when feasible, or immobilization. Reclamation recovery is a permanent treatment that separates metal contaminants from soil in the form of metal, metal oxide or other useful product. Immobilization includes processes that change the physical or chemical properties that impact leaching characteristics or decrease bioavailability and concentration.

Disposal/Discharge. Disposal involves the transfer of contaminated media, concentrated contaminants, or other related materials to a site reserved for treatment or long-term storage of such materials. This generally takes place onsite in a engineered landfill or offsite in an approved commercial or municipal landfill. Disposal does not reduce the concentration or volume of waste; it relocates it to a secure area.

Discharge also involves the transfer of contaminated media. It generally refers to the management of liquids. This response action involves discharging site liquids to an offsite location, such as a wastewater treatment plant, for disposal or further treatment. It also may involve onsite discharge via surface water, injection wells, or infiltration galleries

9.2 PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

For each GRA there are various remediation methods, or technologies, used to carry out the response action. The term technology refers to general categories of technology types, such as thermal treatment. Each technology may have several process options, which refer to the specific material, equipment, or method used to implement a technology. For example, under the technology category of thermal treatment for soil, there may be incineration or thermal desorption process options. These technologies describe broad categories used in remedial action alternatives but do not address details, such as performance data, associated with specific process options.

In the initial phase of technology screening, process options and entire technology types were eliminated from consideration if they were difficult to implement due to their compatibility with site characteristics (e.g., physical features of the site and chemical characteristics of the medium of concern), or if the technology had not been proven to effectively control the COCs. These screening criteria were applied based on published information, experience with the technologies and process options, knowledge of site characteristics, and engineering judgment. Specifically, a technology or process option was rejected during the initial screening because it

- would not be a practical method for the volume or area of contaminated media that is to be remediated;

- would not be an effective method for cleanup of all the contaminants, either as a sole technology or in combination with another technology, because of characteristics or concentrations of contaminants present at the site;

- would not be feasible or effective because of site conditions, including conditions such as location and size, surrounding land use, climate, geology and soils, hydrogeology, and characteristics of the contaminated media;

- could not be effectively administered;

- has not been successfully demonstrated for the site contaminants or media; or

- has extremely high costs relative to other equally effective technologies.

Tables 9-1, **9-2**, and **9-3** describe the process options, present initial screening comments, and summarize the technology screening process for soil, wetland sediment and groundwater, respectively. A description of each process option is included in the table to provide an understanding of each option and to assist in the evaluation of its technical implementability. The screening comments address the technical feasibility and ability of a given process option to serve its intended purpose. The screening comments include a statement as to whether each process option was retained or rejected. The technologies and process options listed in the table were selected based on the fate and transport characteristics of the COCs identified in affected media and on the applicability of a given technology or process option to the soil. The retained technologies and process options are further evaluated in Section 9.3.

Table 9-1 (1 of 2)

Table 9-1 (Page 1 of 2)
Initial Screening of Technologies and Process Options for Contaminated Soil and Solid Media
Ross Metals Site
Rossville, Tennessee

General Response Action	Remedial Technology	Process Option	Description
No Action	None	Not Applicable	Site is left in its existing state.
Institutional Controls	Access and Use Restrictions	Land Use Restrictions	Land use restrictions recorded in property deeds to prohibit activities that might disturb contaminated soil.
		Deed/Zoning Restrictions	Deeds for property in the area of contamination would include restrictions on wells and activities that might disturb contaminated soil.
		Fencing	Security fence installed around contaminated area to limit access.
	Environmental Monitoring	Air, Soil, and/or Groundwater	Site conditions and contaminant levels in these media would be monitored during and after implementation of remedial action.
Containment	Caps	All Processes	Placement of a cap of low permeability material over the area occupied by the contaminated soil to minimize the infiltration of surface water. Cap types include native soil, clay, asphalt, concrete, synthetic membrane, and RCRA multilayer.
	Subsurface Barriers	**All Processes**	Use of grouts, low permeability slurry, or liners placed beneath wastes to limit leaching of contaminants (horizontal barrier) or perpendicular to wastes to form an impermeable barrier (vertical barrier).
Removal	Excavation	All Processes	Use of mechanical excavating equipment to remove and load contaminated soil for transport.
Treatment	**In Situ**	**Biodegradation**	The activity of naturally-occurring microbes is stimulated by circulating water-based solutions through contaminated soil to enhance in situ biological degradation of organic contaminants. Nutrients, oxygen, or other amendments may be used to enhance biodegradation and contaminant desorption from subsurface materials.
		Bioventing	Oxygen is delivered to contaminated unsaturated soil by forced air movement (either extraction or injection of air) to increase oxygen concentrations and stimulate biodegradation. The system also may include the injection of contaminated gases, using the soil system for remediation.
		Phytoremediation	Contaminants are made unavailable to biological organisms after uptake through tree (e.g. poplar) roots.
		Soil Flushing	Water, or water containing an additive to enhance contaminant solubility, is applied to the soil or injected into the groundwater to raise the water table into the contaminated soil zone. Contaminants are leached into the groundwater, which is then extracted and captured/treated/ removed.
		Soil Vapor Extraction	Vacuum is applied through extraction wells to create a pressure gradient that induces gas-phase volatiles to diffuse through soil to extraction wells. The process includes a system for handling offgases. This technology is known as in situ soil venting, in situ volatilization, enhanced volatilization, or soil vacuum extraction.
		Solidification/Stabilization/ Composting/Fixation	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).
		Vitrification	Electrodes for applying electricity, or joule heating, are used to melt contaminated soil, producing a glass and crystalline structure with very low leaching characteristics.
		Steam Extraction	Steam/hot air injection is used to increase the mobility of volatiles and facilitate extraction. The process includes a system for handling offgases.

General Response Action	Remedial Technology	Process Option	Description
	Offsite	**RCRA Hazardous Waste Treatment Facility**	Excavated soil is transported to a RCRA Subtitle C facility for treatment, such as incineration, and subsequent landfill disposal.

Process option eliminated from further consideration

Table 9-1 (Page 2 of 2)

General Response Action	Remedial Technology	Process Option	Description
	Thermal	**Incineration**	High temperatures, 1,600 to 2,200 degrees F, are used to volatilize and combust (in the presence of oxygen) organic contaminants in hazardous waste. Processes include liquid injection, rotary-kiln, fluidized- and circulatory-bed, and infrared.
		Thermal Desorption	Wastes are heated at low or medium temperatures to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to the gas treatment system.
		Pyrometallurgical Processing	Pyrometallurgy encompasses elevated temperature techniques for extraction and processing of metals, including roasting, retorting and smelting for use or disposal. One class of pyrometallurgical processes uses a thermal means to cause volatile metals to separate from the soils and report to the flyash, which is then immobilized.
		Vitrification	Contaminated soil is melted at high temperatures to form glass and crystalline characteristics.
	Biological	**Solid Phase**	Excavated soil is mixed with soil amendments and placed in aboveground enclosures that have leachate collection systems and some form of aeration. Processes include prepared treatment beds, biotreatment cells, and soil piles. Moisture, heat, nutrients, oxygen, and pH may be controlled to enhance biodegradation.
		Slurry Phase	An aqueous slurry is created by combining soil with water and other additives. The slurry is mixed to keep solids suspended and microorganisms in contact with the soil contaminants. Nutrients, oxygen, and pH in the bioreactor may be controlled to enhance biodegradation. Upon completion of the process, the slurry is dewatered and the treated soil is disposed.
	Physical/Chemical	Soil Washing	Contaminants sorbed onto the soil particles are separated from soil in an aqueous-based system. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and heavy metals.
		Solidification/Stabilization/ Composting/Fixation	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions /interactions are induced to help remove organics and heavy metals or otherwise prevent solubilization of contaminants.
		Dehalogenation (Glycolate)	An alkaline polyethylene glycolate (APEG) reagent is used to dehalogenate halogenated aromatic compounds in a batch reactor. Potassium polyethylene glycolate (KPEG) is the most common APEG reagent. Contaminated soil and the reagent are mixed and heated in a treatment vessel. In the APEG process, the reaction causes the polyethylene glycol to replace halogen molecules and render the compound nonhazardous. The reaction between chlorinated organics and KPEG causes replacement of a chlorine molecule and results in a reduction in toxicity.
		MTTD/(Base-Catalyzed Decomposition [BCD])	Contaminated soil is screened, processed with a crusher and pug mill, and mixed with sodium bicarbonate. The mixture is heated in a rotary reactor to decompose and partially volatilize the contaminants. ETG Environmental, Inc. and Separation and Recovery Systems has combined medium temperature thermal desorbers with the BCD process chemistry.
		Solvent Extraction	Waste and solvent are mixed in an extractor, dissolving the organic contaminant into the solvent. The extracted organics and solvent are then placed in a separator, where the contaminants and solvent are separated for treatment and further use.
		Chemical Reduction/Oxidation	Reduction/oxidation chemically converts hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. The reducing/oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, and chlorine. Chemical oxidation is often enhanced using ultraviolet (UV) irradiation or chemical catalysts.

		Gas-Phase Chemical Reduction	The patented ELI Eco Logic International, Inc. uses a gas-phase reduction reaction of hydrogen with organic and chlorinated organic contaminants at elevated temperatures to convert contaminants into a hydrocarbon-rich gas product. Soil is handled within a thermal desorption unit which is operated in conjunction with the reduction reactor.
Disposal	Onsite	Onsite RCRA Landfill	Excavated soil is permanently disposed of in a centrally-located RCRA landfill.
		Backfill Treated Material	Treated soil is placed in a central location or back into excavated areas.
	Offsite	RCRA Landfill (Hazardous or Nonhazardous)	Excavated soil (treated or untreated) is disposed of in a RCRA Subtitle C or D landfill depending on TCLP results.

Process option eliminated from further consideration

Screening Comment

Required for consideration by the NCP.

Retained for further evaluation.

Retained for further evaluation.

Retained for further evaluation.

Retained for further evaluation.

Retained for further evaluation.

Rejected. A large percentage of the total volume of contaminated soil is limited to the surface. It would be more effective and practical to remediate the material in place or remove it for treatment/disposal as opposed to creating barriers around and/or under the areas. In addition, for a vertical barrier, there is no impermeable layer within a reasonable depth into which to key the wall. It would be difficult to predict the reliability of a horizontal barrier over such a large area.

Retained for further evaluation.

Rejected. Used for the treatment of organics.

Rejected. See above comment under biodegradation.

Rejected. Unknown effectiveness for type and concentrations of contaminants present at RM site.

Retained for further evaluation.

Rejected. See above comment under biodegradation.

Retained for further evaluation.

Retained for further evaluation.

Rejected. See above comment under biodegradation. In addition, this process is mainly for the treatment of volatile organics.

Rejected. Not practical or cost effective for the high volume of contaminated material when onsite treatment is a viable option.

Screening Comment
Rejected. Unproven effectiveness for metals.
Rejected. Unproven effectiveness for metals.
Retained for further consideration.
Retained for further consideration.
Rejected. Unproven effectiveness for metals.
Rejected. Unproven effectiveness for metals.
Retained for further evaluation for the treatment of site contaminants.
Retained for further evaluation for the treatment of site contaminants.
Rejected. Ineffective treatment for metals.
Rejected. Ineffective treatment for metals.
Rejected. unproven effectiveness for metals.
Retained for further evaluation for the treatment of site contaminants.

Rejected. Used in conjunction with thermal desorption to promote closed-loop system to alleviate emission problems.

Retained for further evaluation.

Retained for further evaluation.

Retained for further evaluation.

Table 9-2 (Page 1 of 3)
Initial Screening of Technologies & Process Options for Groundwater
Ross Metals Site
Rossville, Tennessee

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
No Action	None	Not Applicable	Site is left in its existing state.	Required for consideration by the NCP.
Institutional Controls	Access and Use Restrictions	Groundwater Use Restrictions	Restrictions placed on use and withdrawal of groundwater for domestic purposes.	Retained for further evaluation.
		Deed/Zoning Restrictions	Deeds for property in the area of contamination would include restrictions on wells.	Retained for further evaluation.
	Alternate Water Supply	**All Processes**	Contaminated water supply is replaced by a noncontaminated water supply. Options include use of bottled water, home treatment units, and installation of new potable supply wells.	Not required since aquifer is not used as a source of drinking water.
	Environmental Monitoring	Air, Soil, Sediment, Surface Water, and/or Groundwater	Site conditions and contaminant levels in these media would be monitored during and after implementation of remedial action.	Retained for further evaluation.
Containment	Caps	All Processes	Placement of a cap of low permeability material over contaminated area to minimize the infiltration of surface water. Cap types include native soil, clay, asphalt, concrete, synthetic membrane, and RCRA multilayer.	Capping would only be used if contaminated soil remains in place. This would be addressed as part of the soil remedial alternatives.
	Subsurface Barriers	**All Processes**	Use of grouts, low permeability slurry, or liners placed beneath wastes to limit leaching of contaminants (horizontal barrier) or perpendicular to wastes to form an impermeable barrier (vertical barrier).	Rejected. No impermeable layer within a reasonable depth in which to key a vertical barrier. Difficult to predict the reliability of a horizontal barrier over a large area.
Collection	Extraction	Extraction Wells	Series of wells installed to collect or extract contaminated groundwater.	Retained for further evaluation.
		Well Points	A group of closely-spaced wells within the contaminated area is connected to a header pipe and pumped by a suction pump.	Retained for further evaluation.
		Subsurface Drains	Perforated pipe or tile with a gravel-filled trench is used to remove or redirect contaminated groundwater.	Retained for further evaluation, especially with regards to the wetlands area.
Treatment	**In Situ**	**Air Sparging**	System of wells to inject air into the aquifer to strip volatile organics from groundwater.	Not applicable for contaminants at site. Mainly for remediation of volatile organics.
		Bioaugmentation	Optimization of environmental conditions by injecting oxygen, nutrients, and (if necessary) microorganisms into the subsurface to enhance microbial degradation of contaminants.	Pesticides may be toxic to the degrading microorganisms. Not effective for treating inorganics.
		Permeable Treatment Bed	Trenches or walls are filled with a permeable medium that reacts with or traps contaminants as contaminated groundwater flows through the trench/wall.	Retained for further evaluation.
	Thermal	**Evaporation**	Contaminated waste stream is placed in large drying beds. Its volume is then reduced or eliminated through vaporization caused by solar heating.	Not practical due to the volume of groundwater requiring treatment and frequent precipitation.
		Incineration	All processes involving combustion of the waste stream.	Not practical for dilute, aqueous waste streams.
		Wet Air Oxidation	Oxidation of organics in an aerator under high temperature and pressure.	Cost of achieving and maintaining elevated temperatures and pressures for dilute groundwater would be excessive compared to conventional physical treatment.

Process option eliminated from further consideration

Table 9-2 (Page 2 of 3)
Initial Screening of Technologies & Process Options for Groundwater
Ross Metals Site
Rossville, Tennessee

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
	Biological	Biological Sorption	An innovative process being developed under the SITE Emerging Technologies Program. The process is based on the affinity of algae cell walls for heavy metal ions, and is being tested for the removal of metal ions containing high levels of dissolved solids from groundwater or surface leachate.	Retained for further evaluation.
		Wetlands-Based Treatment	An innovative approach that uses natural biological and geochemical processes inherent in man-made wetlands to accumulate and remove metals from contaminated water. Process incorporates ecosystem components from wetlands to remove metals by filtration, ion exchange, adsorption, absorption and precipitation through geochemical and microbial oxidation and reduction.	Retained for further evaluation.
		Surface Impoundment/ Lagoon	Aerated process consists of microbial degradation of wastes in an aerated surface impoundment (oxidation pond). Anaerobic process consists of a low surface area to volume ratio (narrow to deep) used to increase degradation action by anaerobic bacteria.	Process is not suitable for low biological oxygen demand, nutrient-deficient waters such as groundwater.
	Offsite	**Hazardous Wastewater Treatment Facility**	Extracted groundwater transported to a treatment, storage, and disposal facility for treatment.	Not practical for high volume, dilute, aqueous waste streams when onsite treatment is a viable option.
	Physical/Chemical	**Air Stripping**	Mixing of large volumes of air with waste stream in a packed column or through diffused aeration to transfer volatile organics to air.	Not applicable to contaminants of concern at site. Mainly for treating volatile organics.
		Carbon Adsorption	Adsorption of contaminants onto activated carbon by passing water through carbon column.	Retained for further evaluation.
		Centrifugation	Stable colloidal particles are removed by the centrifugal forces created by high speed rotation in a cylindrical vessel.	Not applicable to contaminants which are dissolved in groundwater and are not in colloidal suspension.
		Dehalogenation	Chemical agent is mixed with waste stream to strip halogen atoms from chlorinated hydrocarbons.	Primarily used to treat polychlorinated biphenyls (PCBs) which are not of concern at this site.
		Evaporation & Distillation	Volatile organics are separated at optimum temperature and pressure using evaporation followed by condensation.	Not practical for dilute waste streams; highly energy-intensive.
		Filtration	Removal of suspended particles by passing the liquid waste stream through a granular or fabric media.	Retained for further evaluation.
		Ion Exchange	Contaminated water is passed through a resin bed where ions are exchanged between resin and water.	Retained for further evaluation.
		Liquid-Liquid Extraction	Two liquids are separated by the addition of a third liquid that is a solvent for one of the liquids and is insoluble for the other liquid. Final solvent/solute stream is separated by distillation or chemical means.	The variety of groundwater contaminants may require several solvents. Groundwater may become contaminated due to residuals from the extraction solvent(s).
		Neutralization	A chemical reagent is added to the waste stream to alter the pH.	Retained for further evaluation.
		Oil-Water Separation	A gravity-based process used to separate two immiscible liquids, such as petroleum and water.	Not applicable since no free product has been encountered at the site.
		Oxidation	An oxidizing agent(s) (ozone, hydrogen peroxide, permanganate, etc.) is introduced into a contactor and mixed with the waste stream. Contaminants are then oxidized either to intermediate compounds or ultimately to carbon dioxide and water.	Process is primarily used to treat cyanides and phenols which are not of concern at the site.

Process option eliminated from further consideration

Table 9-2 (Page 3 of 3)
Initial Screening of Technologies & Process Options for Groundwater
Ross Metals Site
Rossville, Tennessee

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
		Precipitation/Coagulation/ Flocculation	A chemical agent is mixed with the waste stream to form an insoluble product that can be removed from the waste stream by settling. Usually in conjunction with coagulation and flocculation and as a pretreatment step before organics treatment where the process could be easily fouled by inorganics.	Retained for further evaluation.
		Aeration	Water is saturated with oxygen to remove volatile compounds.	Not applicable to site contaminants.
		Reduction	A reducing agent is mixed with the waste stream to lower the oxidation state of the waste and render it less toxic or more treatable.	Retained for further evaluation.
		Resin Adsorption	Process is similar to carbon adsorption with a resin replacing the carbon as the absorbent.	Current data insufficient to determine reliability of process in treating site contaminants. Applicable to wastewater containing phenols and explosive materials.
		Reverse Osmosis	Use of high pressure to force water through a membrane leaving contaminants behind.	Retained for further evaluation.
		Sedimentation	Suspended solids removed from liquid by gravity in a tank or lagoon. Often preceded by precipitation.	Retained for further evaluation.
		Steam Stripping	Mixing of large volumes of steam with the waste stream in a packed column or through diffused aeration to transfer volatile organics to the air.	Not applicable to contaminants of concern at site, except for ammonia. Mainly for treating volatile organics.
		Ultrafiltration	Removal of medium to high molecular weight solutes from solution by a semipermeable membrane under a low pressure gradient.	Not applicable to contaminants of concern.
Discharge	Onsite	Surface Water	Discharge of treated water to an surface water body.	Retained for further evaluation.
		Injection Wells	Discharge of treated water by injection through onsite wells.	Retained for further evaluation.
		Spray Irrigation	Treated water discharged through plant uptake, evaporation and percolation through soil.	Not feasible because of shallow depth to groundwater; mounding would occur. Would need large area for implementation.
		Infiltration	Treated water allowed to infiltrate into the aquifer through use of open pond or underground piping	Not feasible because of shallow depth to groundwater; mounding would occur. Would need large area for implementation.
	Offsite	POTW	Extracted and/or treated groundwater discharged to local public-owned treatment works (POTW).	Retained for further evaluation.

Process option eliminated from further consideration

Table 9-3 (Page 1 of 4)
Initial Screening of Technologies and Process Options for Wetlands Sediments
Ross Metals Site
Rossville, Tennessee

General Response Action	Remedial Technology	Process Option	Description
No Action	None	Not Applicable	Site is left in its existing state.
Institutional Controls	Access and Use Restrictions	Land Use Restrictions	Land use restrictions recorded in property deeds to prohibit activities that might disturb contaminated soil.
		Deed/Zoning Restrictions	Deeds for property in the area of contamination would include restrictions on wells and activities that might disturb contaminated soil.
		Fencing	Security fence installed around contaminated area to limit access.
	Environmental Monitoring	Sediment, Surface Water, Biota	Site conditions and contaminant levels in these media would be monitored during and after implementation of remedial action.
Containment	Caps	All Processes	Placement of a cap of low permeability material over the area occupied by the contaminated soil to minimize the infiltration of surface water. Cap types include native soil, clay, asphalt, concrete, synthetic membrane, and RCRA multilayer.
	Subsurface Barriers	**All Processes**	Use of grouts, low permeability slurry, or liners placed beneath wastes to limit leaching of contaminants (horizontal barrier) or perpendicular to wastes to form an impermeable barrier (vertical barrier).
	Surface Water Control/Diversion	Grading	Use of standard earthwork construction equipment and methods to shape or slope the finished surface and thus manage surface water infiltration and runoff.
		Revegetation	Planting and cultivation of a vegetative cover with substantial root growth to retain the sediment under anticipated erosive forces. Will minimize erosion, reduce runoff, and contribute to the development of aesthetic cover.
		Dikes and Berms	Construction of embankments engineered to divert or retain water from a specific area. Would provide protection by diverting flow to drainage ways or by acting as a barrier between drainage areas.
		Channels and Waterways	Construction of open conduits to transmit water flow. Used to intercept runoff or reduce slope length.
		Levees and Floodwalls	Construction of flood-protection structures and embankments in areas subject to flooding by rivers or tidal water.
		Baffle	Implementation of a device such as a plate, wall, or screen to deflect, check, or regulate flow and prevent short circuiting.
	Sediment Control/Separation	**Screen**	Use of screens for solids separation from water. Coarse screen types include bar screens, wedge wire screens, traveling screens, or vibrating screens; fine screens include static or rotary screens.
		Sedimentation	Use of sedimentation processes to remove particulate and collodial solids and flocculent suspensions from water. Heavy solids are allowed to settle causing them to separate from the suspending liquid. Such processes include settling basins and impoundments.
		Filtration	Separation of solid particles from water using a porous medium. The driving force is a pressure gradient, cause by gravity centrifugal force, vacuum, or higher-than-atmospheric pressure. Examples include fibrous fabric, diatomaceous earth, and granular material.
		Flocculation	Addition of flocculants where they adhere readily to suspended solids and to each other to create large particles.
		Oil-Water Separator	Use of a gravity-based process to separate to immiscible liquids, such as petroleum and water; can be used to collect sediment and separate from water.
		Wet Detention Pond	Construction of ponds to increase temporary storage within a watershed. Water is delayed in a certain area for a certain period of time, thus lessening surface water constituent loadings being discharged through runoff or flow into other areas. These ponds can remove suspended and

dissolved constituents by sedimentation, physical and chemical interactions, and biological processes.

Table 9-3 (Page 2 of 4)

General Response Action	Remedial Technology	Process Option	Description
Removal	Excavation	All Processes	Use of mechanical excavating equipment to remove and load contaminated soil for transport.
	Dredging	All Processes	Use of mechanical dredges (e.g. dragline, backhoe, clamshell) to dislodge sediment material or hydraulic dredges (e.g. plain suction, cutter head, dust pan, hopper, portable) to remove sediment in liquid slurry form.
	Dewatering	Mechanical Processes	Mechanical dewatering uses processes where water is forced out of the sediment by mechanically induced pressure including filtration, belt filter presses, chamber filtration, rotary filtration, centrifuges, and gravity thickening.
		Air Drying Processes	Moisture is removed by natural evaporation and gravity or by induced drainage. Processes include drying beds and lagoons.
Treatment	**In Situ**	**Biodegradation**	The activity of naturally-occurring microbes is stimulated by circulating water-based solutions through contaminated soil to enhance in situ biological degradation of organic contaminants. Nutrients, oxygen, or other amendments may be used to enhance biodegradation and contaminant desorption from subsurface materials.
		Bioventing	Oxygen is delivered to contaminated unsaturated soil by forced air movement (either extraction or injection of air) to increase oxygen concentrations and stimulate biodegradation. The system also may include the injection of contaminated gases, using the soil system for remediation.
		Phytoremediation	Contaminants are made unavailable to biological organisms after uptake through tree (e.g. poplar) roots.
		Soil Flushing	Water, or water containing an additive to enhance contaminant solubility, is applied to the soil or injected into the groundwater to raise the water table into the contaminated soil zone. Contaminants are leached into the groundwater, which is then extracted and captured/treated/ removed.
		Soil Vapor Extraction	Vacuum is applied through extraction wells to create a pressure gradient that induces gas-phase volatiles to diffuse through soil to extraction wells. The process includes a system for handling offgases. This technology is known as in situ soil venting, in situ volatilization, enhanced volatilization, or soil vacuum extraction.
		Solidification/Stabilization/ Composting/Fixation	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).
		Vitrification	Electrodes for applying electricity, or joule heating, are used to melt contaminated soil, producing a glass and crystalline structure with very low leaching characteristics.
		Steam Extraction	Steam/hot air injection is used to increase the mobility of volatiles and facilitate extraction. The process includes a system for handling offgases.
	Offsite	**RCRA Hazardous Waste Treatment Facility**	Excavated soil is transported to a RCRA Subtitle C facility for treatment, such as incineration, and subsequent landfill disposal.

Process option eliminated from further consideration

General Response Action	Remedial Technology	Process Option	Description
	Thermal	**Incineration**	High temperatures, 1,600 to 2,200 degrees F, are used to volatilize and combust (in the presence of oxygen) organic contaminants in hazardous waste. Processes include liquid injection, rotary-kiln, fluidized- and circulatory-bed, and infrared.
		Thermal Desorption	Wastes are heated at low or medium temperatures to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to the gas treatment system.
		Pyrometallurgical Processing	Pyrometallurgy encompasses elevated temperature techniques for extraction and processing of metals, including roasting, retorting and smelting for use or disposal. One class of pyrometallurgical processes uses a thermal means to cause volatile metals to separate from the soils and report to the flyash, which is then immobilized.
		Vitrification	Contaminated soil is melted at high temperatures to form glass and crystalline characteristics.
	Biological	**Solid Phase**	Excavated soil is mixed with soil amendments and placed in aboveground enclosures that have leachate collection systems and some form of aeration. Processes include prepared treatment beds, biotreatment cells, and soil piles. Moisture, heat, nutrients, oxygen, and pH may be controlled to enhance biodegradation.
		Slurry Phase	An aqueous slurry is created by combining soil with water and other additives. The slurry is mixed to keep solids suspended and microorganisms in contact with the soil contaminants. Nutrients, oxygen, and pH in the bioreactor may be controlled to enhance biodegradation. Upon completion of the process, the slurry is dewatered and the treated soil is disposed.
	Physical/Chemical	Soil Washing	Contaminants sorbed onto the soil particles are separated from soil in an aqueous-based system. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and heavy metals.
		Solidification/Stabilization/ Composting/Fixation	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions /interactions are induced to help remove organics and heavy metals or otherwise prevent solubilization of contaminants.
		Dehalogenation (Glycolate)	An alkaline polyethylene glycolate (APEG) reagent is used to dehalogenate halogenated aromatic compounds in a batch reactor. Potassium polyethylene glycolate (KPEG) is the most common APEG reagent. Contaminated soil and the reagent are mixed and heated in a treatment vessel. In the APEG process, the reaction causes the polyethylene glycol to replace halogen molecules and render the compound nonhazardous. The reaction between chlorinated organics and KPEG causes replacement of a chlorine molecule and results in a reduction in toxicity.
		MTTD/(Base-Catalyzed Decomposition [BCD])	Contaminated soil is screened, processed with a crusher and pug mill, and mixed with sodium bicarbonate. The mixture is heated in a rotary reactor to decompose and partially volatilize the contaminants. ETG Environmental, Inc. and Separation and Recovery Systems has combined medium temperature thermal desorbers with the BCD process chemistry.
		Solvent Extraction	Waste and solvent are mixed in an extractor, dissolving the organic contaminant into the solvent. The extracted organics and solvent are then placed in a separator, where the contaminants and solvent are separated for treatment and further use.
		Chemical Reduction/Oxidation	Reduction/oxidation chemically converts hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. The reducing/oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, and chlorine. Chemical oxidation is often enhanced using ultraviolet (UV) irradiation or chemical catalysts.
		Gas-Phase Chemical Reduction	The patented ELI Eco Logic International, Inc. uses a gas-phase reduction reaction of hydrogen with organic and chlorinated organic contaminants at elevated temperatures to convert contaminants into a hydrocarbon-rich gas product. Soil is handled within a thermal desorption unit which is operated in conjunction with the reduction reactor.
Disposal	Onsite	Onsite RCRA Landfill	Excavated soil is permanently disposed of in a centrally-located RCRA landfill.
		Backfill Treated Material	Treated soil is placed in a central location or back into excavated areas.
	Offsite	RCRA Landfill	Excavated soil (treated or untreated) is disposed of in a RCRA Subtitle C or D landfill depending on TCLP results.

(Hazardous or Nonhazardous)

Table 9-3 (Page 4 of 4)

Mitigation	Onsite	Wetlands Restoration	Wetland soil and vegetation removed as part of a remedial action are replaced, typically at a 1:1 ratio for area and functional value.
	Offsite	Wetlands Creation	An offsite wetlands area is created to mitigate the loss of the wetlands onsite. Wetlands may be created at a 2:1 or greater ratio of created to destroyed wetlands.
		Wetlands Mitigation Bank	Credits are purchased in a wetlands mitigation bank, probably at a ration of 2:1 or greater. to mitigate destruction of wetlands.

Process option eliminated from further consideration

Screening Comment
Required for consideration by the NCP.
Retained for further evaluation.
Retained for further evaluation.
Retained for further evaluation.
Retained for further evaluation.
Retained for further evaluation.
Rejected. A large percentage of the total volume of contaminated soil is limited to the surface. It would be more effective and practical to remediate the material in place or remove it for treatment/disposal as opposed to creating barriers around and/or under the areas. In addition, for a vertical barrier, there is no impermeable layer within a reasonable depth into which to key the wall. For a horizontal barrier, it would be difficult to predict the reliability of the barrier over such a large area.
Retained for further evaluation.
Retained for further evaluation.
Retained for further evaluation.
Retained for further evaluation.
Retained for further evaluation.
Retained for further evaluation.
Eliminated from further consideration; not as effective in dealing with fine sediments.
Retained for further evaluation.
Eliminated from further consideration. Other effective and less costly options available.
Retained for further evaluation.

Screening Comment
Retained for further evaluation.
Retained for further evaluation.
Retained for further evaluation.
Retained for further evaluation.
Rejected. Used for the treatment of organics.
Rejected. See above comment under biodegradation.
Rejected. Unknown effectiveness for type and concentrations of contaminants present at RM site.
Retained for further evaluation.
Rejected. See above comment under biodegradation.
Retained for further evaluation.
Retained for further evaluation.
Rejected. See above comment under biodegradation. In addition, this process is mainly for the treatment of volatile organics.
Rejected. Not practical or cost effective for the high volume of contaminated material when onsite treatment is a viable option.

Screening Comment
Rejected. Unproven effectiveness for metals.
Rejected. Unproven effectiveness for metals.
Retained for further consideration.
Retained for further consideration.
Rejected. Unproven effectiveness for metals.
Rejected. Unproven effectiveness for metals.
Retained for further evaluation for the treatment of site contaminants.
Retained for further evaluation for the treatment of site contaminants.
Rejected. Ineffective treatment for metals.
Rejected. Ineffective treatment for metals.
Rejected. unproven effectiveness for metals.
Retained for further evaluation for the treatment of site contaminants.
Rejected. Used in conjunction with thermal desorption to promote closed-loop system to alleviate emission problems.
Retained for further evaluation.
Retained for further evaluation.
Retained for further evaluation.

Retained for further evaluation.

Retained for further evaluation.

Retained for further evaluation.

9.3 EVALUATION OF RETAINED TECHNOLOGIES AND PROCESS OPTIONS

Incorporation of all process options that survive initial screening into detailed alternatives would result in a cumbersome number of remedial action alternatives. To reduce that number, process options that survived initial screening were reevaluated on the basis of effectiveness, implementability, and cost. In cases where several process options had similar evaluations, a single process option considered representative of each technology type was selected. Identifying a representative process option for each technology type was not intended to limit the process options that could be employed in the remedial design, but instead, provide a basis for evaluation of a manageable number of alternatives. In some cases, more than one process option may have been selected for a technology type because the options were sufficiently different in performance to preclude selecting one as representative of all. The choice of specific process options for a selected technology can and should be evaluated more completely during the remedial design phase.

Effectiveness. Specific technology processes were evaluated for their effectiveness in protecting human health and the environment and in satisfying one or more of the RAOs defined for each category of media. This evaluation compared the effectiveness of the process options within the same technology types, while maintaining a variety of technologies needed to develop a range of alternatives. This criterion focused on

- the degree to which a process option reduces M/T/V through treatment and minimizes residual risks;
- the effectiveness in handling the estimated areas or volume of media and meeting the RGOs identified;
- the effectiveness in protecting human health and the environment during the construction phase and operation and how quickly it achieves protection;
- the degree to which the process option complies with all requirements; and
- how proven and reliable the process option is with respect to the contaminants at the site.

Options providing significantly less effectiveness than other, more promising options were eliminated.

Implementability. This criterion focused on the technical feasibility and availability of the option and the administrative feasibility of implementing the option. During the first screening, process options that were ineffective or unworkable at the site were eliminated as being technically feasible. The secondary screening continued the evaluation on a more detailed level, placing greater emphasis on the institutional aspects. Implementability considered

- availability of treatment, storage, and disposal services as well as capacity, and
- availability of necessary equipment and skilled workers to implement the technology.

Options that were technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time were eliminated from further consideration.

Cost. The costs of construction and any long-term costs associated with operation and maintenance (O&M) were considered. Costs that were excessive compared to the overall effectiveness of options was considered as one of several factors used to eliminate options. Options providing effectiveness and implementability similar to those of another option by employing a similar method of treatment or engineering control, but at a greater cost, were eliminated. It should be noted that the greatest cost variability during site remediation is generally seen between the technology types, rather than within specific process options in a given technology.

Relative costs are used rather than detailed estimates. At this stage in the process, the cost analyses are subjectively made on the basis of engineering judgment. Each process option was evaluated as to whether costs are high, moderate, or low relative to other process options of the same technology groups. In terms of dollars, cost ranges with respect to total cost consisted of

- high = >$5 million,
- moderate = $1 to $5 million, and
- low = <$1 million.

The evaluation of the retained technologies and process options based on effectiveness, implementability, and cost is presented in **Tables 9-4 through 9-6**. A summary of the retained technologies and process options is presented in **Tables 9-7 through 9-9**. These technologies and process options were used in the development of the remedial action alternatives as presented in Section 10.0. For soils, six process options were eliminated from further analysis. In situ soil flushing was omitted since residual flushing additives in the soil may be a concern (especially in the wetlands), and the technology would require the construction of slurry walls, collection wells or subsurface drains, presenting difficulties in the wetlands. In situ solidification and stabilization also was eliminated from further consideration, since the in situ treatment introduces chemical agents into the ground which may cause a pollution problem in itself. Both in situ and ex situ vitrification, as well as pyrometallurgical processing were eliminated from further consideration because of the anticipated high cost relative to other treatment technologies and site-specific implementation problems that would need to be addressed in order for this technology to be effective. Chemical reduction/oxidation was screened out from further consideration as extensive treatability testing would be required to evaluate the overall effectiveness of the technology on site contaminants, and solids must be in solution. Finally, creation of an onsite RCRA landfill was eliminated from further consideration because of space requirements, the need for compliance with state landfill siting requirement, as well as permanent restrictions on future land use and long-term maintenance.

The process options screened out from further consideration for surface soils, also were screened out from further consideration for wetland sediments. In addition, filtration as a means of sediment control/separation was screened from further consideration, as other process options are more appropriate for the RM site wetlands and are readily available. Finally, the purchase of credits in a wetlands mitigation bank to replace functional value of destroyed wetlands is

Table 9-4 (Page 1 of 2)
Evaluation of Process Options for Contaminated Soils and Solid Media
Ross Metals Site
Rossville, Tennessee

General Response Action	Remedial Technology	Process Option	Effectiveness
No Action	None	Not Applicable	Does not achieve any measure of remediation or meet RAOs.
Institutional Controls	Access and Use Restrictions	Land Use Restrictions	Does not achieve any measure of remediation or meet RAOs. Effectiveness depends on enforcement of restrictions. Used in conjunction with other technologies.
		Deed/Zoning Restrictions	Does not achieve any measure of remediation or meet RAOs. Effectiveness depends on future land use. Used in conjunction with other technologies.
		Fencing	Does not achieve any measures of remediation or meet RAOs. Provides minimal protection to receptors. Site is already fenced. Used in conjunction with other technologies.
	Environmental Monitoring	Air, Soil, and/or Groundwater	Does not achieve any measure of remediation or meet RAOs. Useful for tracking contaminant migration and/or effectiveness of remedial actions. Used in conjunction with other technologies.
Containment	Caps	All Processes	Would effectively minimize the potential for direct contact with contaminated material, if properly maintained. Would be effective in reducing surface infiltration. Does not treat contamination (leaves it in place). May slow down natural bioremediation processes.
Removal	Excavation	All Processes	Proven, reliable technology. Would effectively reduce the potential threat to human health. Short-term effects include noise and fugitive dust emissions. Would be used in conjunction with an ex situ treatment technology.
Treatment	**In Situ**	**Soil Flushing**	Soil flushing has a more established history for the treatment of organics, but has been used for treatment of Cr removal and is being applied to a Superfund site for treatment of Cr, Hg, and Pb in soils and wastes. Recovered flushing fluids may need treatment to meet appropriate discharge standards prior to release to a POTW or receiving waters. Residual flushing additives in the soil may be a concern and should be evaluated on a site-specific basis.
		Solidification/Stabilization/ Fixation/Composting	In situ cement-based solidification/stabilization is demonstrated to depths of 30 feet and may be able to extend to 150 feet. In situ treatment introduces chemical agents into the ground which may cause a pollution problem in itself, and may be subject to additional requirements.
		Vitrification	Vitrification may or may not be applicable for Pb, As, and Cd, depending on the level of difficulty encountered in retaining metals in the melt, and controlling and treating any volatile emissions that may occur.
	Thermal	**Pyrometallurgical Processing**	Pyrometallurgical processing usually is preceded by physical treatment to produce a uniform feed material and upgrade the metal content. In order for this technology to be technically feasibly, it must be possible to generate a concentrate from the contaminated soil that will be acceptable to the processor.
		Vitrification	Vitrification may or may not be applicable for Pb, As, and Cd, depending on the level of difficulty encountered in retaining metals in the melt, and controlling and treating any volatile emissions that may occur.

Process option eliminated from further consideration

General Response Action	Remedial Technology	Process Option	Effectiveness
	Physical/Chemical	**Soil Washing**	Should be effective for the removal of metals. Will result in a concentration of contaminants. Successful treatment of metal-loaded leachant is required for the successful cleaning of soil. Soil washing has been applied or selected at several Superfund sites.
		Solidification/Stabilization/ Composting/Fixation	Solidification/Stabilization proven effectiveness for metals removal. Would not reduce the volume or toxicity of contaminants, only their mobility by binding and encapsulating them. Use of biosolids, and biosolid composting to restore metals contaminated land is an emerging technology with limited full scale application.
		Chemical Reduction/Oxidation	May be effective for metal contaminants at the site. Extensive treatability testing would be required to evaluate the overall effectiveness. Incomplete oxidation or formation of intermediate contaminants may occur depending upon the contaminants and oxidizing agents used.
Disposal	Onsite	**Onsite RCRA Landfill**	Proven, effective method of disposing of contaminated soil. Material from offsite would be excavated and consolidated onsite. Would minimize the potential for direct contact with contaminated material. Does not treat contamination.
		Backfill Treated Material	Effective means for placement of treated material back onsite. Note that land disposal restrictions must be met prior to placement.
	Offsite	RCRA Subtitle C landfill	Excavation and removal of contaminated soil to a RCRA landfill have been performed in the past at lead battery recycling sites but probably will not continue unless the materials are treated prior to disposal due to landban restrictions (LDRs).

Process option eliminated from further consideration

Implementability	Cost
Readily implementable since no action is taken.	Negligible
Readily implementable.	Minimal
Readily implementable.	Minimal
Readily implementable. Requires long-term maintenance. Equipment, services, and personnel readily available. Existing site fencing may require upgrade.	Low capital; low O&M
Readily implementable. No construction or operation is necessary. Equipment, services, and personnel are already available and procedures are in place.	Low capital; negligible O&M
Implementable. Conventional technology. Equipment, personnel, and services readily available. Requires restrictions on future land use and long-term maintenance.	Moderate to high capital; moderate O&M
Easily implementable. Equipment, personnel, and services readily available.	Moderate capital; negligible O&M
Soil flushing is most applicable to contaminants that are relatively soluble in the extracting fluid, and that will not tend to sorb onto soil, as the flushing fluid proceeds to the extraction point. A single target metal would be preferable to multiple metals. The equipment used for this technology is relatively easy to construct and operate, but may require the installation of slurry walls or other containment structure, collection wells, or subsurface drains.	Moderate to high capital; moderate O&M
The site must be prepared for the construction, operation, maintenance, decontamination, and decommissioning of equipment, and site characteristics, such as soil topography and load-bearing capacity are important considerations.	Moderate to high capital; moderate O&M
In situ vitrification faces implementation problems where contaminated soil is less than 6 ft bgs or contaminated soil is mixed with buried metal, as is the case at the RM site.	High to very high capital, high O&M
Few pyrometallurgical systems are currently available in mobile or transportable configurations. Offsite treatment must comply with EPA's offsite treatment policies and procedures. Unless a very concentrated feed steam can be generated, there will be a charge, in addition to transportation, for processing the concentrate.	High capital; high O&M
Ex situ vitrification faces implementation problems where waste contains >25% moisture content (causing excessive fuel consumption), metals concentration in soils exceed their solubility in glass, or As is present in waste (may require pretreatment to produce less volatile forms).	High to very high capital, high O&M

Implementability	Cost
May be implementable at the RM site, although effectiveness on slag unknown. Residuals would have to be further treated and disposed.	High capital; moderate O&M
Requires relatively simple technologies; easy to construct and operate. May result in a significant increase in volume.	Moderate to high capital; moderate O&M
Solids must be in solution. Waste composition must be well-known to prevent the inadvertent production of a more toxic or more hazardous end product.	Moderate capital; moderate O&M
Would require compliance with state landfill siting requirements, as well as other landfill regulations. Requires permanent restrictions on future land use and long-term maintenance. Because of the large volume of contaminated soil, it may be more "attractive" to actually treat the material onsite rather than to turn the site into a large landfill, unless soil is consolidated into a smaller area which will increase the overall height; thus potentially making it aesthetically displeasing.	Moderate capital; high O&M
Readily implementable. It is assumed that treated material from offsite would be placed at the site.	Low capital; negligible O&M
Readily implementable. However, this technology requires knowledge of LDRs and other regulations developed by state government regarding RCRA hazardous wastes.	Moderate to high capital; negligible O&M

Table 9-5 (Page 1 of 2)
Evaluation of Groundwater Process Options
Ross Metals Site
Rossville, Tennessee

General Response Action	Remedial Technology	Process Option	Effectiveness	Implementability	Cost
No Action	None	Not Applicable	Does not achieve any measure of remediation or meet RAOs.	Readily implementable since no action is taken.	Negligible
Institutional Controls	Access and Use Restrictions	Groundwater Use Restrictions	Does not achieve any measure of remediation or meet RAOs. Effectiveness depends on enforcement activities. Used in conjunction with other technologies.	Readily implementable.	Minimal
		Deed/Zoning Restrictions	Does not achieve any measure of remediation or meet RAOs. Effectiveness depends on future land use. Used in conjunction with other technologies.	Readily implementable.	Minimal
	Environmental Monitoring	Air, Soil, Sediment, Surface Water, and/or Groundwater	Does not achieve any measure of remediation or meet RAOs. Useful for tracking contaminant migration and/or effectiveness of remedial actions. Used in conjunction with other technologies or monitored natural attenuation.	Readily implementable. No construction or operation is necessary. Equipment, services, and personnel are already available and procedures are in place.	Low capital and negligible O&M
Containment	Caps	All Processes	Would effectively minimize the potential for infiltration of surface water into contaminated area, although it does not treat contamination.	Easily implemented. Equipment, services, and personnel readily available. Requires long-term maintenance.	Moderate to high capital; moderate O&M
Collection	Extraction	Extraction Wells	Effective in removing contaminated groundwater from an aquifer. A proven technology. Used in conjunction with groundwater treatment and/or hydraulic controls.	Easily implemented. Equipment, services, and personnel readily available. Requires long-term maintenance.	Low to moderate capital (depending on depth of wells), moderate O&M
		Well Points	Not effective for aquifers deeper than 20 ft bgs. Groundwater table at RM occurs 11 ft bgs and is anticipated to extend to 45 ft bgs.	Easily implemented. Equipment, services, and personnel readily available. Requires long-term maintenance.	Low capital, low to moderate O&M
		Subsurface Drains	Effective in removing contaminated groundwater from an aquifer. A proven technology. Used in conjunction with groundwater treatment and/or hydraulic controls.	Easily implemented. Equipment, services, and personnel readily available. Requires long-term maintenance.	Low capital, low to moderate O&M
Treatment	In Situ	Permeable Treatment Beds	Testing required to select reactive media, design wall and prove ultimate effectiveness.	Easily implemented. Equipment, services, and personnel readily available. Relatively low maintenance required.	Low capital and O & M
	Biological	**Biological Sorption**	Unproven. Currently being tested under SITE program.	Anticipate that the process would be easy to implement and that equipment, services, and personnel would be readily available.	Moderate capital and O&M
		Wetlands-Based Treatment	Wetland vegetation has been shown to remove substantial amounts of cadmium, copper, iron, lead and zinc from contaminated water. However, offsite wetlands adjacent to the RM site already have significant levels of metal contamination	Anticipate that the process would be easy to implement and that equipment, services, and personnel would be readily available.	Moderate capital and O&M
	Physical/Chemical	**Carbon Adsorption**	Most effective method for removing organics from a water residual waste stream or as a post-treatment polishing step. Eliminated because site COCs are metals.	Easily implemented. Equipment, services, and personnel readily available. Requires maintenance including disposal or regeneration of spent carbon.	Moderate capital and O&M
		Filtration	Conventional technology. Used as a pretreatment step for other process options.	Easily implemented. Requires other technology to treat filtered contaminants.	Low capital and O&M
		Ion Exchange	Effective for removal of heavy metals and nitrates/nitrites. Also effective as a polishing step. Testing would be required to prove ultimate effectiveness.	Easily implemented through standard construction and operating techniques. Ion exchange resins are prone to fouling by organic substances. Sludge produced may require disposal as a hazardous waste.	Moderate capital and O&M
		Neutralization	Effective process for treating certain metals by altering pH thus causing metals to drop out. Used as a pretreatment step for other options.	Easily implemented. Equipment, services, and personnel readily available. Treated water may require further treatment before final discharge.	Moderate capital, low O&M

Process option eliminated from further consideration

Table 9-5 (Page 2 of 2)
Evaluation of Groundwater Process Options
Ross Metals Site
Rossville, Tennessee

General Response Action	Remedial Technology	Process Option	Effectiveness	Implementability	Cost
		Precipitation/Coagulation/ Flocculation	Effective and proven technology for removing metal compounds from water.	Easily implemented. Equipment, services, and personnel readily available.	Moderate capital and O&M
		Reduction	Chemical reduction is primarily used for treatment of wastes containing hexavalent chromium, mercury, and lead.	Easily implemented. Equipment, services, and personnel readily available.	Moderate capital and O&M
		Reverse Osmosis	Effective in removing metals from contaminated groundwater from a low volume waste stream. Not as effective for larger volume waste streams.	Equipment, services, and personnel readily available. Would require an elaborate system for a small quantity of metals. Membrane fouling could be a problem.	High capital and O&M
		Sedimentation	Conventional technology. Used as a pretreatment step for other options. Effective and proven means for the removal of metals from solution.	Easily implementable with standard construction and operating techniques.	Low capital, moderate O&M
Discharge	Onsite	Surface Water	Effective and proven method for disposing of treated groundwater.	Easily implemented with conventional construction materials and methods. Will require NPDES permit. Discharge requirements may be stringent and difficult to meet.	Low capital and O&M
		Injection Wells	Effective and proven means for disposing of treated groundwater. May be effective in improving extraction rates. However, it would be more effective to discharge to the wetlands if extracting groundwater could potentially pull water away from that area.	Easily implemented with conventional construction materials and methods. Will require compliance with state underground injection control requirements.	Low capital and O&M
	Offsite	POTW	Effective, proven method of disposing of treated groundwater. May only have to be partially treated to meet POTW requirements.	Easily implemented with conventional construction materials and methods. Will require compliance with POTW pretreatment standards.	Moderate to high capital, low O&M

Process option eliminated from further consideration

Table 9-6 (Page 1 of 3)
Evaluation of Process Options for Wetlands Sediment
Ross Metals Site
Rossville, Tennessee

General Response Action	Remedial Technology	Process Option	Effectiveness
No Action	None	Not Applicable	Does not achieve any measure of remediation or meet RAOs.
Institutional Controls	Access and Use Restrictions	Land Use Restrictions	Does not achieve any measure of remediation or meet RAOs. Effectiveness depends on enforcement of restrictions. Used in conjunction with other technologies.
		Deed/Zoning Restrictions	Does not achieve any measure of remediation or meet RAOs. Effectiveness depends on future land use. Used in conjunction with other technologies.
		Fencing	Does not achieve any measures of remediation or meet RAOs. Provides minimal protection to receptors. Site is already fenced. Used in conjunction with other technologies.
	Environmental Monitoring	Sediment, Surface Water, Biota	Does not achieve any measure of remediation or meet RAOs. Useful for tracking contaminant migration and/or effectiveness of remedial actions. Used in conjunction with other technologies.
Containment	Caps	All Processes	Would effectively minimize the potential for direct contact with contaminated material, if properly maintained. Would be effective in reducing surface infiltration. Does not treat contamination (leaves it in place). May slow down natural bioremediation processes.
	Surface Water Control/Diversion	Grading	Moderately effective in reducing infiltration of surface water run-on and run-off
		Dikes and Berms	Effective in providing short- and long-term protection through the diversion of water around a contaminated area or in the development of a settling basin or detention pond.
		Channels and Waterways	Would be effective in diverting runoff from facility around wetlands
		Levees and Floodwalls	Effective in prevention of surface water flow during extreme storm events
		Baffle	Effective for controlling water movement into possible sedimentation areas
	Sediment Control/Separation	Sedimentation	Effective as a means of allowing sediment to settle out from water and be collected in a portion of the wetlands.
		Filtration	Might be effective at removing sediment from water at various points across the wetlands.
		Flocculation	Effective in conjuntion with sedimentation.
		Wet Detention Pond	Effective as a means of holding water in specified portion of wetlands to allow sediment to settle out and/or to raise water level sufficiently to minimize exposure of ecological receptors to contaminated sediment.
		Revegetation	Moderately effective at minimizing the spread of sediments through erosion.

General Response Action	Remedial Technology	Process Option	Effectiveness
Removal	Excavation	All Processes	Proven, reliable technology. Would effectively reduce the potential threat to human health. Short-term effects include noise and fugitive dust emissions. Would be used in conjunction with an ex situ treatment technology.
	Dredging	All Processes	Proven, reliable technology. Would effectively reduce the potential threat to human health. Short-term effects include noise and fugitive dust emissions. Would be used in conjunction with an ex situ treatment technology.
	Dewatering	All Processes	Previous treatability studies indicate the wetlands sediment may be difficult to dewater.
Treatment	In Situ	**Soil Flushing**	Soil flushing has a more established history for the treatment of organics, but has been used for treatment of Cr removal and is being applied to a Superfund site for treatment of Cr, Hg, and Pb in soils and wastes. Recovered flushing fluids may need treatment to meet appropriate discharge standards prior to release to a POTW or receiving waters. Residual flushing additives in the soil may be a concern and should be evaluated on a site-specific basis.
		Solidification/Stabilization/ Fixation/Composting	In situ cement-based solidification/stabilization is demonstrated to depths of 30 feet and may be able to extend to 150 feet. In situ treatment introduces chemical agents into the ground which may cause a pollution problem in itself, and may be subject to additional requirements. Biosolid compost applied to wetlands sediment may be effective in making lead contamination unavailable to bioreceptors.
		Vitrification	Vitrification may or may not be applicable for Pb, As, and Cd, depending on the level of difficulty encountered in retaining metals in the melt, and controlling and treating any volatile emissions that may occur.
	Thermal	**Pyrometallurgical Processing**	Pyrometallurgical processing usually is preceded by physical treatment to produce a uniform feed material and upgrade the metal content. In order for this technology to be technically feasibly, it must be possible to generate a concentrate from the contaminated soil that will be acceptable to the processor.
		Vitrification	Vitrification may or may not be applicable for Pb, As, and Cd, depending on the levl of difficulty encountered in retaining metals in the melt, and controlling and treating any volatile emissions that may occur.

Process option eliminated from further consideration

Table 9-6 (Page 3 of 3)

General Response Action	Remedial Technology	Process Option	Effectiveness
	Physical/Chemical	**Soil Washing**	Should be effective for the removal of metals. Will result in a concentration of contaminants. Successful treatment of metal-loaded leachant is required for the successful cleaning of soil. Soil washing has been applied or selected at several Superfund sites.
		Solidification/Stabilization/ Composting/Fixation	Solidification/Stabilization proven effectiveness for metals removal. Would not reduce the volume or toxicity of contaminants, only their mobility by binding and encapsulating them. Use of biosolids, and biosolid composting to restore metals contaminated land is an emerging technology with limited full scale application.
		Chemical Reduction/Oxidation	May be effective for metal contaminants at the site. Extensive treatability testing would be required to evaluate the overall effectiveness. Incomplete oxidation or formation of intermediate contaminants may occur depending upon the contaminants and oxidizing agents used.
Disposal	Onsite	**Onsite RCRA Landfill**	Proven, effective method of disposing of contaminated soil. Material from offsite would be excavated and consolidated onsite. Would minimize the potential for direct contact with contaminated material. Does not treat contamination.
		Backfill Treated Material	Effective means for placement of treated material back onsite. Note that land disposal restrictions must be met prior to placement.
	Offsite	RCRA Subtitle C landfill	Excavation and removal of contaminated soil to a RCRA landfill have been performed in the past at lead battery recycling sites but probably will not continue unless the materials are treated prior to disposal due to landban restrictions (LDRs).
Mitigation	Onsite	Wetlands Restoration	Would be effective at replacing functional value of wetlands lost due to remedial activity
	Offsite	Wetlands Creation	Would be effective at replacing functional value of wetlands lost due to remedial activity
		Wetlands Mitigation Bank	Would be effective at replacing functional value of wetlands lost due to remedial activity

Process option eliminated from further consideration

Implementability	Cost
Readily implementable since no action is taken.	Negligible
Readily implementable.	Minimal
Readily implementable.	Minimal
Readily implementable. Requires long-term maintenance. Equipment, services, and personnel readily available. Existing site fencing may require upgrade.	Low capital; low O&M
Readily implementable. No construction or operation is necessary. Equipment, services, and personnel are already available and procedures are in place.	Low capital; negligible O&M
Implementable. Conventional technology. Equipment, personnel, and services readily available. Requires restrictions on future land use and long-term maintenance.	Moderate to high capital; moderate O&M
Readily implementable. Conventional technology. Equipment, services, and personnel are readily available.	Low capital; low O&M
Readily implementable. Conventional technology. Equipment, services, and personnel are readily available.	Low capital; low O&M
Readily implementable. Conventional technology. Equipment, services, and personnel are readily available.	Low capital; low O&M
Readily implementable. Conventional technology. Equipment, services, and personnel are readily available.	Moderate Capital; low O&M
Readily implementable. Conventional technology. Equipment, services, and personnel are readily available.	Low capital; low O&M
Requires some surface water control/diversion to create area where sedimentation could occur.	High capital; low O&M
Would require surface water control/diversion to implement effectively.	High capital; low O&M
Readily implementable. Conventional technology. Equipment, services, and personnel are readily available.	Low capital; low O&M
Readily implementable. Conventional technology. Equipment, services, and personnel are readily available.	High capital; low O&M
Readily implementable. Conventional technology. Equipment, services, and personnel are readily available.	Low capital; low O&M

Implementability	Cost
Easily implementable. Equipment, personnel, and services readily available.	Moderate capital; negligible O&M
Easily implementable. Equipment, personnel, and services readily available.	Moderate capital; negligible O&M
Readily implementable. Equipment, personnel and services readily available.	Moderate capital; negligible O&M
Soil flushing is most applicable to contaminants that are relatively soluble in the extracting fluid, and that will not tend to sorb onto soil, as the flushing fluid proceeds to the extraction point. A single target metal would be preferable to multiple metals. The equipment used for this technology is relatively easy to construct and operate, but may require the installation of slurry walls or other containment structure, collection wells, or subsurface drains.	Moderate to high capital; moderate O&M
The site must be prepared for the construction, operation, maintenance, decontamination, and decommissioning of equipment, and site characteristics, such as soil topography and load-bearing capacity are important considerations.	Moderate to high capital; moderate O&M
In situ vitrification faces implementation problems where contaminated soil is less than 6 ft bgs or contaminated soil is mixed with buried metal, as is the case at the RM site.	High to very high capital, high O&M
Few pyrometallurgical systems are currently available in mobile or transportable configurations. Offsite treatment must comply with EPA's offsite treatment policies and procedures. Unless a very concentrated feed steam can be generated, there will be a charge, in addition to transportation, for processing the concentrate.	High capital; high O&M
Ex situ vitrification faces implementation problems where waste contains >25% moisture content (causing excessive fuel consumption), metals concentration in soils exceed their solubility in glass, or As is present in waste (may require pretreatment to produce less volatile forms).	High to very high capital, high O&M

Implementability	Cost
May be implementable at the RM site, although effectiveness on slag unknown. Residuals would have to be further treated and disposed.	High capital; moderate O&M
Requires relatively simple technologies; easy to construct and operate. May result in a significant increase in volume.	Moderate to high capital; moderate O&M
Solids must be in solution. Waste composition must be well-known to prevent the inadvertent production of a more toxic or more hazardous end product.	Moderate capital; moderate O&M
Would require compliance with state landfill siting requirements, as well as other landfill regulations. Requires permanent restrictions on future land use and long-term maintenance. Because of the large volume of contaminated soil, it may be more "attractive" to actually treat the material onsite rather than to turn the site into a large landfill, unless soil is consolidated into a smaller area which will increase the overall height; thus potentially making it aesthetically displeasing.	Moderate capital; high O&M
Readily implementable. It is assumed that treated material from offsite would be placed at the site.	Low capital; negligible O&M
Readily implementable. However, this technology requires knowledge of LDRs and other regulations developed by state government regarding RCRA hazardous wastes.	Moderate to high capital; negligible O&M
Readily implementable. Requires assessment of functional value of destroyed wetlands	Moderate to high capital; negligible O&M
Readily implementable. Requires assessment of functional value of destroyed wetlands. Probably requires a 2:1 creation to loss ratio.	High capital; negligible O&M
Requires assessment of functional value of destroyed wetlands. Probably requires a 2:1 creation to loss ratio. No mitigation banks in vicinity of RM site.	High capital; negligible O&M

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Table 9-7

Summary of Retained Technologies and Process Options for Contaminated Solid Media
Ross Metals Site
Rossville, Tennessee

General Response Action	Remedial Technology	Process Option
No Action	None	Not Applicable
Institutional Controls	Access and Use Restrictions	Land Use Restrictions Deed/Zoning Restrictions Fencing
	Environmental Monitoring	Air, Soil, and/or Groundwater
Containment	Caps	All Processes
Removal	Excavation	All processes
Treatment- Immobilization	Physical/Chemical	Solidification/Stabilization/ Fixation/Composting
Disposal	Onsite	Backfill Treated Material
	Offsite	Subtitle D Landfill

Table 9-8

Summary of Retained Technologies and Process Options for Contaminated Wetlands Sediment Ross Metals Site Rossville, Tennessee

General Response Action	Remedial Technology	Process Option
No Action	None	Not Applicable
Institutional Controls	Access and Use Restrictions	Land Use Restrictions Deed/Zoning Restrictions Fencing
	Environmental Monitoring	Sediment, Surface Water, Biota
Containment	Caps	All Processes
	Surface Water Control/Diversion	All Processes
	Sediment Control/Separation	Sedimentation Flocculation Wet Detention Pond
Removal	Excavation Dredging Dewatering	All Processes All Processes All Processes
Treatment (In situ or ex situ)- Immobilization	Physical/Chemical	Solidification/Stabilization/ Fixation/Composting
Disposal	Onsite Offsite	Backfill Treated Material Subtitle D Landfill
Mitigation	Onsite Offsite	Wetlands Restoration Wetlands Creation

Table 9-9

Summary of Retained Technologies and Process Options for Groundwater
Ross Metals Site
Rossville, Tennessee

General Response Action	Remedial Technology	Process Option
No Action	None	Not Applicable
Institutional Controls	Access and Use Restrictions	Groundwater Use Restrictions Deed/Zoning Restrictions
	Environmental Monitoring	Air, Soil, and/or Groundwater
Containment	Caps	All Processes
Collection	Extraction	Extraction Wells Well Points Subsurface Drains
Treatment	In Situ	Permeable Treatment Beds
	Physical/Chemical	Filtration Ion Exchange Neutralization Precipitation/Coagulation/Flocculation Reduction Sedimentation
Discharge	Onsite	Surface Water
	Offsite	POTW

eliminated from further consideration as no mitigation banks exist in the vicinity of the RM site, and functional value of destroyed wetlands can be replace through restoration or creation of an off-site wetlands.

For groundwater remediation, both biological sorption and the wetlands-based treatment process were eliminated from further consideration as they are unconventional treatments that are as of yet unproven for effective treatment of metals; especially considering the levels of metals already present in the wetlands adjacent to the RM site. Carbon adsorption was screened out from further evaluation as it is most effective for removing organics while other treatment options are readily available for the treatment of metals contamination. Reverse osmosis also was eliminated from further consideration, as it is most feasible for metals removal from a low volume stream.

Finally, the use of injection wells to discharge treated groundwater was eliminated from further consideration because the relatively high water table in the area limits the effectiveness and appropriateness of injection wells.

10.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

The objective of this section is to combine the list of previously screened technologies and process options to form a range of remedial action alternatives for the RM site. To address the site-specific RAOs, a variety of alternatives were formulated by combining the retained technologies in Section 9.3. The range of alternatives for surface soil/sediment includes no action, institutional controls, containment, removal, treatment, and disposal options. Groundwater alternatives include no action, institutional controls, containment, collection, treatment, and discharge options.

In formulating alternatives, contaminants with concentrations above remediation goals, applicable technologies, and the contaminants which these technologies most effectively address were considered. The goal in developing remedial action alternatives is to provide a range of cleanup options together with sufficient information to adequately compare alternatives against each other.

Each alternative developed and described in this section was evaluated to determine its overall effectiveness, implementability, and cost. These criteria for alternative evaluation are similar to that previously used to evaluate the process options. The use of effectiveness, implementability, and cost as evaluation criteria has been defined in Section 9.3.

After each criterion was evaluated, remedial alternatives with the most favorable overall evaluations were retained to undergo detailed analysis. The screening procedure attempts to maintain representative alternatives from a full range of technologies. Those alternatives not selected may be considered at a later step during the design stage if information is developed that identifies an additional advantage not previously apparent or an alternative for a similar retained alternative that continues to be evaluated favorably. A summary of the developed alternatives for the RM site is presented in **Tables 10-1, 10-2**, **and 10-3** for surface soil, wetlands sediment and groundwater.

Table 10-1
Development of Remedial Action Alternatives for Surface Soil

Ross Metals Site
Rossville, Tennessee

Alternative	Description of Alternative
1	No Action
2	Capping Land use/deed restrictions Fencing Media monitoring Demolition of pavement and buildings Landfilled slag left in place Excavate and consolidate contaminated soils and sediments onsite Excavation to create onsite disposal area Cap contaminated sediments and soils Revegetate/restore excavated wetlands Surface controls, as necessary
3	Capping with pavement left in place Land use/deed restrictions Fencing Media monitoring Demolition of buildings Landfilled slag left in place Excavate and consolidate contaminated soils and sediments onsite Cap contaminated sediments and surface soil Revegetate/restore excavated wetlands Surface controls, as necessary
4	Capping with Construction of Above-ground Disposal Cell Land use/deed restrictions Fencing Media monitoring Demolition of buildings Landfilled slag left in place Excavate and consolidate contaminated soils and sediments onsite Cap contaminated sediments and surface soil Revegetate/restore excavated wetlands Surface controls, as necessary
5 Option A	Excavation, Onsite Treatment w/Solidification/stabilization Onsite Disposal Demolition of buildings and pavement Excavate contaminated soil, sediment, and landfilled slag Consolidate material onsite and treat by solidification/stabilization Excavate onsite disposal area Dispose of treated material back into onsite excavated area Revegetate/restore excavated wetlands Media monitoring

Table 10-1 (continued)

Alternative	Description of Alternative
5 Option B	Excavation, Onsite Treatment w/Solidification/stabilization Offsite Disposal Demolition of buildings and pavement Excavate contaminated soil, sediment, and landfilled slag Consolidate material onsite and treat by solidification/stabilization Dispose of treated material into offsite RCRA Subtitle D Landfill Revegetate/restore excavated wetlands Media monitoring
6 Option A	Capping w/Excavation & Onsite Treatment of Principal-Threat Waste And Containment of Low-Level Threat Waste Onsite Disposal of Treated Principal-Threat Waste Land use/deed restrictions Fencing Media monitoring Demolition of buildings Excavation of landfilled slag Excavate and consolidate contaminated soils and sediments onsite Consolidate principal threat waste onsite and treat by stabilization/solidification Cap low-level threat and treated principal-threat sediments and surface soil onsite Revegetate/restore excavated wetlands Surface controls, as necessary
Option B	Offsite Disposal of Treated Principal-Threat Waste Land use/deed restrictions Fencing Media monitoring Demolition of buildings Excavation of landfilled slag Excavate and consolidate contaminated soils and sediments onsite Consolidate principal threat waste onsite and treat by stabilization/solidification Cap low-level threat waste sediments and surface soil onsite Dispose of treated principal-threat waste in offsite RCRA Subtitle D landfill Revegetate/restore excavated wetlands Surface controls, as necessary

NOTE: For the purpose of developing treatment-based alternatives involving immobilization technologies, the terms "solidification" and "stabilization" are used. However, other immobilization technologies, such as fixation , or other physical or chemical reaction/interaction such as biosolid composting, that prevents solubilization of contaminants and limits the bioavailability of contaminants also may be appropriate for consideration.

Table 10-2
Development of Remedial Action Alternatives for Wetlands Sediments
Ross Metals Site
Rossville, Tennessee

Alternative	Description of Alternative
1	No Action
2	Offsite Creation of Wetlands Land use/deed restrictions Fencing Media monitoring
3	Creation of Wet Detention Ponds Over Specified Areas in Wetlands Land use/deed restrictions Fencing Media monitoring Surface Water Control/Diversion Surface controls, as necessary
4	Capping Contaminated Sediment in Place Land use/deed restrictions Fencing Media monitoring Cap contaminated sediments Surface Water Control/Diversion Surface controls, as necessary Creation of offsite wetlands
5	In Situ Treatment With Wetlands Restoration Land use/deed restrictions Media Monitoring In situ treatment using biosolids composting Wetlands Restoration
6	Excavation and Consolidation with Site Soils and Final Disposition Per Selected Soil Alternative, and Wetlands Restoration

Table 10-3

Development of Remedial Action Alternatives for Groundwater
Ross Metals Site
Rossville, Tennessee

Alternative	Description of Alternative
1	No Action
2	Limited Action Groundwater use with deed restrictions Media monitoring Contingency Extraction/Treatment/Discharge Alternative
3	Capping with pavement left in place Land use/deed restrictions Fencing Media monitoring Landfilled slag left in place Cap contaminated sediments and surface soil Surface controls, as necessary
4	Pump contaminated groundwater via extraction wells, well points and/or subsurface drains Onsite treatment using a physical and/or chemical treatment, e.g.: precipitation/flocculation/coagulation sedimentation ion exchange neutralization, reduction, fixation Discharge to surface water or POTW Temporary deed restrictions Media monitoring
5	Permeable Treatment Bed (i.e., treatment wall) In situ treatment using a physical, chemical or biological process, e.g.: precipitation sorption Temporary Deed Restrictions Media Monitoring

10.1 SURFACE SOIL ALTERNATIVES ANALYSIS

The alternatives that were selected for surface soil at the RM site include no action, capping, capping with pavement left in place, capping with construction of an above-ground disposal cell, excavation with solidification/stabilization and onsite disposal, excavation with solidification/stabilization and offsite disposal, excavation with solidification/stabilization of principal-threat waste and onsite capping of low-level threat waste and treated principal-threat waste, and excavation with solidification/stabilization of principal-threat waste with offsite disposal of treated principal-threat waste, and onsite capping of low-level threat waste.

10.1.1 ALTERNATIVE 1 -- NO ACTION

10.1.1.1 Description

Under this alternative, no action would be taken to remedy the contaminated surface soil, slag, sediment, or other solid media at the site. The alternative would only involve the continued monitoring of structures, surface soil, slag, sediment, and surface water quality at the site. Approximately five wipe samples (from buildings) and ten surface soil and fifteen surface water/sediment samples would be collected from the affected areas and analyzed for the PCOCs found in each medium every five years for 30 years. Public health evaluations would be conducted every five years and would allow EPA to assess the ongoing risks to human health and the environment posed by the RM site. The evaluations would be based on the data collected from media monitoring.

10.1.1.2 Effectiveness

The no action alternative is required by the NCP to be carried through the screening process, as it serves as a baseline for comparison of the site remedial action alternatives. This alternative does not reduce the exposure of receptors to site contaminants. Continued migration of contaminants and the resulting exposure of receptors would occur. As a result, this alternative is not effective in protecting human health or the environment, or reducing M/T/V of contaminants at the site. Monitoring proposed under this alternative would allow EPA to assess the ongoing threats to human health and the environment posed by the site.

10.1.1.3 Implementability

The only task which would require implementation under this alternative is the periodic media monitoring at the site. This alternative could be easily implemented since monitoring equipment is readily available and procedures are in place.

10.1.1.4 Cost

Minimal costs are associated with this alternative relative to other remedial action alternatives. No capital costs are associated with this alternative. Annual O&M costs for media sampling associated with monitoring exists.

10.1.2 ALTERNATIVE 2 -- CAPPING

10.1.2.1 Description

Capping the contaminated solid media at the RM site would serve to prevent rainfall infiltration and future leaching into the groundwater. In addition, capping also would limit direct contact exposure to contaminated media under the cap. Varying degrees of capping can be implemented depending on the severity of contaminants in the area. Caps can range from a simple natural soil cap to a multilayer soil/synthetic cap. This alternative evaluates a geosynthetic cap for implementation. This type of cap would produce a low permeability barrier sufficient to reduce contaminant migration.

This alternative includes the demolition of most of the on-site pavement and buildings. The main office building and the pavement immediately surrounding this building would remain on site, and landfilled slag would remain in place. Contaminated soil beneath the pavement would be excavated up to a 3 ft maximum depth and consolidated with the stockpiled slag, pavement, and building debris. This waste material would be disposed in an on-site excavation that would extend from the existing landfill to about 375 feet south of the landfill. This disposal area would be about 400 feet wide and 8 feet deep, although could be enlarged somewhat if necessary. A geosynthetic cap and underlying 1.5-ft soil cushion layer would be added above the waste and existing landfill to cover about 6.7 acres. A 1.2-ft soil cover and 6-inch topsoil layer would be placed over the entire site. These components are outlined as follows:

- Demolition of pavement and buildings
- Excavation of onsite contaminated soil (15,625 CY)
- Excavation of an on-site disposal area (375 ft long by 400 ft wide by 8 ft deep; approximately 36,200 CY subsurface soil)
- Compaction of 26,325 CY of waste material (15,625 CY of waste soil; 6,000 CY of stockpiled slag; 3,700 CY of pavement; and 1,000 CY of building debris) into disposal area (Compaction of 35,625 CY of waste material if excavated wetland sediment is consolidated with surface soil for final disposition)
- Installation of 1.5-ft-deep soil cushion over the waste and existing landfill (20,300 CY)
- Installation of geomembrane liner and geotextile over soil cushion (6.7 acres)
- Soil cover (1.2 ft deep), topsoil cover (6 inches deep), and grass seeding over the site (8 acres)
- Land/deed use restrictions and fencing

The topsoil layer of the cap would be graded to a minimum slope of 3% and a maximum of 5% to promote surface drainage away from the waste cell and reduce infiltration. Surface drainage controls would be constructed around the perimeter of the cap to collect surface water runoff.

Alternative 2 would eliminate direct contact with contaminated media, eliminate on-site physical hazards, minimize contaminant migration to groundwater, and eliminate contaminant migration to surface water from the site. **Figure 10-1** illustrates the components of the cap included in this alternative as they would be applied to the RM site.

10.1.2.2 Effectiveness

This alternative virtually eliminates the risks associated with the exposure pathways. Since the cap would eliminate exposure to contaminants, risk to human health is greatly reduced. The cap also would limit the mobility of hazardous constituents be reducing the forces that drive the contaminants, such as infiltration of surface water in the capped area. Under this alternative, contaminated media would be buried within several feet of the water table. The existing clay unit serves as a geologic barrier between waste and groundwater. Under this alternative, contaminant migration to groundwater is not eliminated since contaminated media remain in the ground, however, the reduction of surface water infiltration could reduce groundwater contaminant migration. Risk-based RGOs would be met above the cap, since the contaminated material is being isolated. Finally, long-term monitoring would be required to assess any potential impacts of this alternative.

10.1.2.3 Implementability

Implementation of this alternative is considered technically feasible and could be accomplished through conventional construction methods. However, because the site is located in a floodplain, the cap construction will need to be implemented in accordance with existing criteria and standards set forth under the National Flood Insurance Program and will need to include the

figure 10-1

use of acceptable floodproofing and/or flood protection measures. In addition, the capped area may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities (e.g., siting) would apply to the site.

Equipment, services, and personnel should be readily available from many vendors. Routine and periodic cap inspection and a maintenance program would be necessary to seal cracks and ensure that vegetation remains established.

10.1.2.4 Cost

Moderate costs are associated with this alternative relative to other remedial alternatives. Expenditures include capital costs for equipment , construction of the cap, as well as fencing upgrades and deed restrictions. Annual and periodic O&M costs also exist and include such items as media monitoring and periodic mowing and maintenance of the cap and site.

10.1.3 ALTERNATIVE 3 -- CAPPING WITH PAVEMENT IN PLACE

10.1.3.1 Description

Alternative 3 differs from Alternative 2 in that the waste is not disposed of in an excavation, but rather spread over the existing pavement and capped in place with the existing landfill. Alternative 3 includes the demolition of most of the on-site buildings. The main office building would remain on site, and the landfilled slag would remain in place. Contaminated soil from areas not covered by pavement would be excavated and consolidated with the stockpiled slag and building debris, and excavated wetland sediment. This waste material would be spread above the pavement that extends from the existing landfill to about 375 feet south of the landfill. A geosynthetic cap and underlying 1.5-ft soil cushion layer would be added above the waste and existing landfill and would cover about 6.7 acres. The totsl height of the capped area would be and existing landfill and would cover approximately 6.7 acres. The total height of the capped area would be approximately 5 feet. A 1-ft soil cover and 6-inch topsoil layer would be placed over the entire site. The components of this alternative are outlined as follows:

- Demolition of buildings
- Excavation of contaminated soil in southeastern corner of the site (2,800 CY)
- Compaction of 9,800 CY of waste material above pavement and landfill (2,800 CY of waste soil; 6,000 CY of stockpiled slag; and 1,000 CY of building debris) (Compaction of 19,100 CY of waste material if excavated wetlands sediment is consolidated with surface soil for final disposition)
- Installation of 1.5-ft-deep soil cushion over waste and existing landfill (20,300 CY)
- Installation of geomembrane liner and geotextile over soil cushion (6.7 acres)
- Soil cover (1 ft deep), topsoil cover (6 inches deep), and grass seeding over site (8 acres)
- Land use/deed restrictions and fencing

The topsoil layer of the cap would be graded to a minimum slope of 3% and a maximum of 5% to promote surface drainage away from the waste cell and reduce infiltration. Surface drainage controls would be constructed around the perimeter of the cap to collect surface water runoff.

Alternative 3 would eliminate direct contact with contaminated media, eliminate on-site physical hazards, further minimize contaminant migration to groundwater, and eliminate contaminant migration to surface water from the site. **Figure 10-2** illustrates the components of the cap included under this alternative as applied to the RM site.

fig10-2

10.1.3.2 <u>Effectiveness</u>

Under this alternative, contaminated media would be consolidated above the existing pavement and capped above grade. The existing clay unit would remain intact from ground surface to depths of 7 to 20 feet bgs throughout the site. The clay unit would act as a geologic barrier to isolate contaminated media and prevent its migration to groundwater to a greater extent than Alternative 2. Surface water infiltration that contributes to the migration of contaminants to groundwater would be eliminated by using an impermeable geomembrane cap. This alternative virtually eliminates the risks associated with the exposure pathways. Since the cap would eliminate exposure to contaminants, risk to human health is greatly reduced. Risk-based RGOs would be met above the cap, since the contaminated material is being isolated. Finally, long-term monitoring would be required to assess any potential impacts of this alternative.

10.1.3.3 <u>Implementability</u>

Implementation of this alternative is considered to be technically feasible and could be accomplished through conventional construction methods. However, because the site is located in a floodplain, the cap construction will need to be implemented in accordance with existing criteria and standards set forth under the National Flood Insurance Program and will need to include the use of acceptable floodproofing and/or flood protection measures. In addition, the capped area may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities (e.g., siting) would apply to the site. Implementation factors discussed under Alternative 2 also apply to this alternative.

10.1.3.4 <u>Cost</u>

Moderate costs are associated with this alternative relative to other remedial alternatives. Expenditures include capital costs for equipment, construction of the cap, as well as fencing upgrades and deed restrictions. Annual and periodic O&M costs also exist and include such items as media monitoring and periodic mowing and maintenance of the cap and site.

10.1.4 ALTERNATIVE 4 -- CAPPING WITH CONSTRUCTION OF ABOVE-GROUND DISPOSAL CELL

10.1.4.1 <u>Description</u>

Alternative 4 differs from Alternatives 2 and 3 in that waste is not disposed of in the area of the existing pavement; instead, it is consolidated over the surface of the existing landfill and capped in place. This method would result in a disposal cell approximately 15 feet high through out the landfill area. This alternative includes the demolition of most of the on-site pavement and buildings. The main office building and the pavement immediately surrounding this building would remain on site, and landfilled slag would remain in place. Contaminated soil beneath the pavement would be excavated up to a 3 ft maximum depth and consolidated with the stockpiled slag, pavement, and building debris. This alternative includes the following components:

- Demolition of pavement and buildings
- Excavation of onsite contaminated soil (15,625 CY)
- Compaction of 26,325 CY of waste material (15,625 CY of waste soil; 6,000 CY of stockpiled slag; 3,700 CY of pavement; and 1,000 CY of building debris) in existing landfill area with a cell height of about 12 to 13 feet (Compaction of 35,625 CY of waste material, with a cell height of 15 feet if excavated wetlands sediment are consolidated with surface soils for final disposition
- Installation of 1.5-ft-deep soil cushion over the waste and existing landfill (7,600 CY)
- Installation of geomembrane liner and geotextile over soil cushion (2.5 acres)
- Soil cover (1 ft deep), topsoil cover (6 inches deep), and grass seeding over the site (8 acres)
- Land use/deed restrictions and fencing

Surface drainage controls would be constructed around the perimeter of the cap to collect surface water runoff.

Alternative 4 would eliminate direct contact with contaminated media, eliminate on-site physical hazards, minimize contaminant migration to groundwater, and eliminate contaminant migration to surface water from the site. **Figure 10-3** illustrates the components of the cap included under this alternative as applied to the RM site.

10.1.4.2 Effectiveness

This alternative virtually eliminates the risks associated with the exposure pathways. Since the cap would eliminate exposure to contaminants, risk to human health is greatly reduced. The cap also would limit the mobility of hazardous constituents by reducing the forces that drive the contaminants, such as infiltration of surface water in the capped area. The existing clay unit would remain intact from ground surface to depths of 7 to 20 feet bgs throughout the site, and serve as a geologic barrier between waste and groundwater. Under this alternative, contaminant migration to groundwater is not eliminated since contaminated media remain in the ground, however, the reduction of surface water infiltration could reduce groundwater contaminant migration. Risk-based RGOs would be met above the cap, since the contaminated material is being isolated. Finally, long-term monitoring would be required to assess any potential impacts of this alternative.

10-3

10.1.4.3 Implementability

Implementation of this alternative is considered technically feasible and could be accomplished through conventional construction methods. However, because the site is located in a floodplain, the cap construction will need to be implemented in accordance with existing criteria and standards set forth under the National Flood Insurance Program and will need to include the use of acceptable floodproofing and/or flood protection measures. In addition, the capped area may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities (e.g., siting) would apply to the site. Equipment, services, and personnel should be readily available from many vendors. Routine and periodic cap inspection and a maintenance program would be necessary to seal cracks and ensure that vegetation remains established.

10.1.4.4 Cost

Moderate costs are associated with this alternative relative to other remedial alternatives. Expenditures include capital costs for equipment, construction of the cap, as well as fencing upgrades and deed restrictions. Annual and periodic O&M costs also exist and include such items as media monitoring and periodic mowing and maintenance of the cap and site.

10.1.5 ALTERNATIVE 5 -- EXCAVATION AND ONSITE TREATMENT WITH SOLIDIFICATION/STABILIZATION

OPTION A - ONSITE DISPOSAL OF TREATED WASTE

10.1.5.1 Description

Option A for Alternative 5 includes the decontamination and demolition of most of the on-site pavement and buildings. The main office building and the pavement immediately surrounding this building would remain on site. The building debris and pavement would be decontaminated by steam/pressure cleaning. Contaminated soil throughout the site, and buried slag in the landfill would be excavated and consolidated with the stockpiled slag. Contaminants within soil and slag would be physically bound or enclosed within a stabilized mass (solidification), or chemical reactions would be induced between a stabilizing agent and the contaminant to reduce its mobility (stabilization). Solidification/stabilization treatment technologies include the addition of cement, lime, pozzolan, or silicate-based additives or chemical reagents that physically or chemically react with the contaminant. Once treated and confirmed to be nonhazardous, the soil and slag would be consolidated with the pavement debris and disposed of in an on-site, unlined excavation. The decontaminated building debris would be taken off site to a metal recycling facility. The onsite disposal area would extend from the northern boundary of the existing landfill to about 100 feet north of the site entrance and would be about 700 feet long, 250 feet wide and 8 feet deep. A 3.0-ft soil cover consisting of uncontaminated soil excavated from the disposal area and a 6-inch topsoil layer would be placed over the entire site. The total height of the capped area would be approximately 4.5 feet. The components of this alternative are outlined as follows:

- Decontamination and demolition of pavement and buildings
- Recycling of metal building debris
- Excavation of contaminated soil (21,875 CY) and landfilled slag (10,000 CY)
- Stabilization or solidification of contaminated soil, stockpiled slag, and landfilled slag (about 60,150 tons or 78,750 tons if excavated wetlands sediment are consolidated with surface soil for final disposition)
- Excavation of on-site disposal area (700 ft long by 250 ft wide by 8 ft deep)
- Compaction of 40,817 CY of waste material (52,771 CY of waste material if wetland sediment is included); assuming a 5% increase in volume due to stabilization/solidification
- Soil cover (3.0 ft deep), topsoil cover (6 inches deep), and grass seeding over site (8 acres)
- Land use/deed restrictions and fencing

Alternative 5 would eliminate direct contact with contaminated media, eliminate on-site physical hazards, and eliminate contaminant migration to groundwater and surface water from the site. The final treatment system would depend upon the outcome of treatability testing and would be determined during the remedial design phase. The fixed material would be subjected to TCLP testing to determine if treatment has been effective, prior to placement in the excavated disposal area. **Figure 10-4** illustrates the component of the onsite disposal area included under Alternative 5a.

Treatability testing may be required to demonstrate contaminant immobilization for this treatment process and to help determine the volume increase caused by the solidification/stabilization process. One treatability study to evaluate stabilization reagents that would 1) reduce the leachibility of lead in treated woodland sediment and 2) improve the material handling qualities of the sediment so that free liquids are not released during transport or disposal was completed in March 1998 (EPA 1998) **(Appendix M)**. The results of that study demonstrated that a biosolid product produced by N-Viro effectively reduced the leachibility of lead, absorbed free liquids and resulted in a material that could be excavated and transported for disposal.

Deed restrictions may be placed on the site while the remedial action takes place. Monitoring would be required to assess the effectiveness of the remedial action.

10.1.5.2 <u>Effectiveness</u>

Under this alternative, contaminated media would be treated and converted to a nonhazardous, nonleachable material and buried on site. Migration of hazardous contamination to groundwater would be eliminated because the treated, buried material would effectively bind or bond the

fig 10-4

contaminants, preventing leaching and contaminant migration. This combination of technologies would ensure that the selected treatment system would remediate surface soil and sediment contamination to concentrations meeting remediation goals, and RAOs would be met. Excavation and onsite treatment permanently eliminates the long-term health and environmental risks at the site, as well as reducing contaminant mobility.

10.1.5.3 Implementability

Treatment of contaminated soil and slag is offered by numerous vendors. On-site treatment utilizes standard construction practices and material handling equipment. No significant construction issues are expected to be encountered.

The clay unit present at the site extends from ground surface to an average depth of about 10 feet bgs and appears to be thickest in the western portion. Excavation activities at the site should not extend beneath the base of the clay unit to prevent the confined aquifer from upwelling into the excavated area. For the purpose of this analysis, the average excavation depth of the disposal area is assumed to be 8 feet bgs. Actual depths of excavation may vary across the site.

Treatment of the contaminated waste will likely increase the volume of the waste soil and slag material; however, slight volume reductions may occur when some chemical reagents are used to treat the material. Typical volume increases range from about 5 percent to as high as 100 percent, depending upon the treatment method used. An increase in the volume of the treated waste material will have an impact on the disposal volume required. Calculations used in the development of this alternative utilized a volume increase estimate of 5 percent.

The dimensions of the site property are about 450 by 800 feet, including the existing landfill. The waste storage capacity required for this alternative is 58,990 CY assuming a 5 percent volume increase of the treated material. To meet the Tennessee Solid Waste Disposal (SWDP) buffer zone siting standards, the excavation area would be 700 by 250 feet, and with an 8-ft average depth, depending on the thickness of the clay unit. The disposal area would be located beneath the existing pavement. The excavated disposal area could be enlarged slightly if placement of the volume of treated material into the 700 by 250 ft excavation leads to unacceptable changes to site topography.

Wastewater may be generated during implementation of this alternative through water runoff generated as a result of dust emission control. Wastewater may also be generated as a result of decontamination activities required for equipment and on-site workers. Containment and treatment or disposal of these wastewaters may be required. Depending upon the treatment methodology selected, the wastewater may be able to be utilized in the soils treatment process.

The on-site disposal area for the treated waste may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities would apply to the site. In addition, because the site is located in a floodplain, the completion of the disposal area will need to be implemented in accordance with existing criteria and standards set forth under the National Flood Insurance Program and will need to include the use of acceptable floodproofing and/or flood protection measures.

10.1.5.4 Cost

Moderate to high costs are associated with this alternative relative to other remedial action alternatives. Typical expenditures would include capital costs for equipment and construction of the treatment system, as well as excavation. In addition, monitoring costs associated with excavation and treatment verification are realized costs.

OPTION B - OFFSITE DISPOSAL OF TREATED MATERIAL

10.1.5.5 <u>Description</u>

Option B for Alternative 5 is similar to Option A in that it also consists of the decontamination and demolition of most of the on-site pavement and buildings and on-site treatment. The main office building and the pavement immediately surrounding this building would remain on site. The building debris and pavement would be decontaminated by steam cleaning. The decontaminated building debris would be taken offsite to a metal recycling facility. Contaminated soil throughout the site, and buried slag in the landfill would be excavated and consolidated with the stockpiled slag. Contaminants in soil and slag would be physically bound or enclosed within a stabilized mass (solidification), or chemical reactions would be induced between a stabilizing agent and the contaminants to reduce mobility (stabilization). Solidification/stabilization treatment technologies include the addition of cement, lime, pozzolan, or silicate-based additives or chemical reagents that physically or chemically react with the contaminant. Option B differs from Option A in that after treatment and confirmation that the soil is nonhazardous, the treated soil and slag would be hauled off site to a disposal facility. A 1.0-ft soil cover and a 6-inch topsoil layer would be placed over the entire site. These components are outlined as follows:

- Decontamination and demolition of pavement and buildings
- Recycling of metal building debris
- Excavation of contaminated soil (21,875 CY), and landfilled slag (10,000 CY)
- Stabilization or solidification of contaminated soil, stockpiled slag, and landfilled slag (about 60,150 tons; or 78,750 tons if excavated wetlands sediment are consolidated with surface soil for final disposition)
- Off-site disposal at nonhazardous disposal facility (63,158 tons assuming a 5 percent increase in volume during treatment; 82,688 tons if excavated wetland sediment is included)
- Bacfill excavation, soil cover (1 ft deep), topsoil cover (6 inches deep), and grass seeding over site (8 acres)

Alternative 5b would eliminate direct contact with contaminated media, eliminate on-site physical hazards, and eliminate contaminant migration to groundwater and surface water from the site.

Deed restrictions may be placed on the site while the remedial action takes place. Monitoring would be required to assess effectiveness of the remedial action.

10.1.5.6 Effectiveness

Under this alternative, contaminated media would be treated and converted to a nonhazardous, nonleachable material and transported to an off-site disposal facility. Migration of hazardous contamination would be eliminated because the material containing contaminant concentrations above the cleanup goals would be treated and removed from the site. This combination of technologies would ensure that the selected treatment system would remediate surface soil to concentrations meeting remediation goals, and RAOs would be met. Excavation and onsite treatment with offsite disposal permanently eliminates the long-term health and environmental risks at the site. This alternative would ensure that the surface soil and sediment concentrations would meet remediation goals and RAOs.

10.1.5.7 Implementability

Treatment of contaminated soil and slag is offered by numerous vendors. On-site treatment utilizes standard construction practices and material handling equipment. No significant construction issues are expected to be encountered. However, because the site is located in a floodplain, the construction of a treatment unit will need to be implemented in accordance with existing criteria and standards set forth under the National Flood Insurance Program and will need to include the use of acceptable floodproofing and/or flood protection measures. Implementation of this process option is considered technically feasible and could be readily implemented. Access to Subtitle D facilities also is available.

Treatment of the contaminated waste will likely increase the volume of the waste soil and slag material; however, slight volume reductions may occur when some chemical reagents are used to treat the material. Typical volume increases range from about 5 percent to as high as 100 percent, depending upon the treatment method used. An increase in the volume of the treated waste material will have an impact on the disposal volume required. Calculations used in the development of this alternative utilized a volume increase estimate of 5 percent.

Wastewater may be generated during implementation of this alternative through water runoff generated as a result of dust emission control. Wastewater may also be generated as a result of decontamination activities required for equipment and on-site workers. Containment and treatment or disposal of these wastewaters may be required. Depending upon the treatment methodology selected, the wastewater may be able to be utilized in the soils treatment process.

As is the case for Option A, treatability testing may be required to demonstrate contaminant immobilization for this treatment process and to help determine the volume increase caused by the solidification/stabilization process.

10.1.5.8 Cost

High costs are associated with this alternative, as a result of offsite disposal costs and transportation of the waste to a disposal facility. Capital costs include equipment for excavation of the contaminated material and the purchase of clean fill. In addition, monitoring costs associated with excavation verification are realized costs.

10.1.6 ALTERNATIVE 6 -- CAPPING WITH EXCAVATION & ONSITE TREATMENT OF PRINCIPAL THREAT WASTE

OPTION A - ONSITE DISPOSAL OF TREATED PRINCIPAL THREAT WASTE

10.1.6.1 Description

Alternative 6 is similar to Alternative 5 in that it also includes the excavation and treatment of contaminated material via solidification/stabilization. However, Alternative 6 differs from Alternative 5 in that treatment is limited to that material that is considered principal-threat. As indicated in section 8.3, principal threat waste at the RM site includes the landfilled and stockpiled slag, and approximately 500 CY of soil.

Option A for Alternative 6 includes the demolition of most of the on-site buildings. The main office building would remain on site. The building debris and pavement would be decontaminated by steam/pressure cleaning. Onsite contaminated soil considered principal threat, and buried slag in the landfill would be excavated and consolidated with the stockpiled slag. In addition, above the RGO, contaminated soil from areas not covered by pavement, and non-principal-threat landfill soil would be excavated for placement in the excavated onsite landfill along with the treated principal-threat waste. This waste (and treated) material would be disposed in the excavated landfill area (450 x 250 ft x 5 ft deep). A geosynthetic cap and underlying 1.5-ft soil cushion layer would be added above the waste and existing landfill and would cover about 2.5 acres. A 1-ft soil cover and 6-inch topsoil layer would be placed over the entire site. The capped disposal area would rise approximately 6 ft above ground surface.

For treatment, contaminants within soil and slag would be physically bound or enclosed within a stabilized mass (solidification), or chemical reactions would be induced between a stabilizing agent and the contaminant to reduce its mobility (stabilization). The decontaminated building debris would be taken offsite to a metal recycling facility. The components of this alternative are outlined as below:

- Decontamination and demolition of buildings
- Recycling of metal building debris
- Excavation of principal-threat contaminated soil (500 CY), landfilled slag (10,000 CY), and non-principal threat landfill soil (6,500 CY) to allow access to landfilled slag. (Excavation of an additional 8,200 CY of principal-threat contaminated

sediment and 1,100 CY of non-principal threat contaminated sediment if contaminated wetlands sediments are excavated and consolidated with surface soils for final disposition)

- Stabilization or solidification of principal-threat contaminated soil, stockpiled slag, and landfilled slag (about 32,700 tons; 45,000 tons if principal-threat wetlands sediments are included).

- Excavation of on-site disposal area (450 ft long by 250 ft wide by 5 ft deep) in landfill area.

- Compaction of 23,825 CY of waste material; assuming a 5% increase in volume of principal-threat material due to stabilization/solidification, and no increase in volume of non-principal threat material (33,535 CY of waste material if contaminated wetlands sediments are excavated and consolidated with surface soils for final disposition)

- Installation of 1.5-ft-deep soil cushion over waste and treated material and low-level threat material capped in place (20,300 CY)

- Installation of geomembrane liner and geotextile over soil cushion (6.7 acres)

- Soil cover (1 ft deep), topsoil cover (6 inches deep), and grass seeding over site (8 acres)

- Land use/deed restrictions and fencing

The final treatment system would depend upon the outcome of treatability testing and would be determined during the remedial design phase. The fixed material would be subjected to TCLP testing to determine if treatment has been effective, prior to placement in the excavated disposal area. Note that the components of this alternative are considered a conceptual design, but other designs may be possible. The final design would be based on requirements regarding construction in a floodplain.

Treatability testing may be required to demonstrate contaminant immobilization for this treatment process and to help determine the volume increase caused by the solidification/stabilization process.

Deed restrictions may be placed on the site while the remedial action takes place. Monitoring would be required to assess the effectiveness of the remedial action.

The topsoil layer of the cap would be graded to a minimum slope of 3% and a maximum of 5% to promote surface drainage away from the waste cell and reduce infiltration. Surface drainage controls would be constructed around the perimeter of the cap to collect surface water runoff.

Option A of Alternative 6 would eliminate direct contact with contaminated media, eliminate on-site physical hazards, minimize contaminant migration to groundwater, and eliminate contaminant migration to surface water from the site. **Figure 10-5** illustrates the components of the cap included under Alternative 6a as applied to the RM site.

10.1.6.2 Effectiveness

Under this alternative, principal-threat contaminated media would be treated and converted to a nonhazardous, nonleachable material and buried on site along with low-level threat waste, while low-level threat soil located beneath the pavement would be capped in place. Migration of hazardous contamination to groundwater would be eliminated because the treated, buried material would effectively bind or bond the contaminants, preventing leaching and contaminant migration. Excavation and onsite treatment permanently eliminates the long-term health and environmental risks at the site, as well as reducing contaminant mobility. In addition, for low-level-threat waste capped in place, the existing clay unit would remain intact from ground surface fig 10-5 to depths of 7 to 20 feet bgs throughout the site. The clay unit would act as a geologic barrier to isolate contaminated media and prevent its migration to groundwater. Surface water infiltration that contributes to the migration of contaminants to groundwater would be eliminated by using an impermeable geomembrane cap. This alternative virtually eliminates the risks associated with the exposure pathways. Since the cap would eliminate exposure to contaminants, risk to human health is greatly reduced. Risk-based RGOs would be met above the cap, since the contaminated material is being isolated. Finally, long-term monitoring would be required to assess any potential impacts of this alternative. This combination of technologies would ensure that the selected treatment system would remediate surface soil and sediment contamination to concentrations meeting remediation goals, and RAOs would be met.

10.1.6.3 Implementability

Implementation of this alternative is considered to be technically feasible and could be accomplished through conventional construction methods. Because the site is located in a floodplain, the completion of the disposal area will need to be implemented in accordance with existing criteria and standards set forth under the National Flood Insurance Program and will need to include the use of acceptable floodproofing and/or flood protection measures. Implementation factors discussed under Alternatives 2, 3, and 4 also apply to this alternative.

Treatment of the contaminated waste will likely increase the volume of the waste soil and slag material; however, slight volume reductions may occur when some chemical reagents are used to treat the material. Typical volume increases range from about 5 percent to as high as 100 percent, depending upon the treatment method used. An increase in the volume of the treated waste material will have an impact on the disposal volume required. Calculations used in the development of this alternative utilized a volume increase estimate of 5 percent.

The on-site disposal area for the low-level threat waste and principal-threat treated waste may be classified as a Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities would apply to the site.

10.1.6.4 <u>Cost</u>

Moderate to high costs are associated with this alternative relative to other remedial alternatives. Expenditures include capital costs for equipment, construction of the cap, as well as fencing upgrades and deed restrictions, construction of the treatment system, as well as excavation. In addition, monitoring costs associated with excavation and treatment verification are realized costs. Annual and periodic O&M costs also exist and include such items as media monitoring and periodic mowing and maintenance of the cap and site.

OPTION B - OFFSITE DISPOSAL OF TREATED PRINCIPAL-THREAT WASTE

10.1.6.5 Description

Option B is similar to Option A except that treated principal-threat waste is disposed offsite in a RCRA subtitle D landfill rather than being capped onsite with the low-level threat waste. Like Option A, Option B for Alternative 6 includes the demolition of most of the on-site buildings. The main office building would remain on site. The building debris and pavement would be decontaminated by steam/pressure cleaning. Onsite contaminated soil considered principal threat, and buried slag in the landfill would be excavated and consolidated with the stockpiled slag. In addition, contaminated soil from areas not covered by pavement, and non-principal-threat landfill soil would be excavated for placement in the excavated onsite landfill. This low level-threat waste material would be disposed in the excavated landfill area (450 x 250 ft x 5 ft deep). A geosynthetic cap and underlying 1.5-ft soil cushion layer would be added above the waste and existing landfill and would cover about 2.5 acres. A 1-ft soil cover and 6-inch topsoil layer would be placed over the entire site.

For treatment, contaminants within soil and slag would be physically bound or enclosed within a stabilized mass (solidification), or chemical reactions would be induced between a stabilizing agent and the contaminant to reduce its mobility (stabilization). The decontaminated building debris would be taken offsite to a metal recycling facility. The components of this alternative are outlined as below:

- Decontamination and demolition of buildings
- Recycling of metal building debris
- Excavation of principal-threat contaminated soil (500 CY), landfilled slag (10,000 CY), and non-principal threat landfill soil (6,500 CY) to allow access to landfilled slag. (Excavation of an additional 8,200 CY of principal-threat contaminated wetland sediment and 1,100 CY of non-principal threat contaminated wetland sediment if contaminated wetland sediments are excavated and consolidated with surface soil for final disposition)
- Stabilization or solidification of principal-threat contaminated soil and wetland sediment, stockpiled slag, and landfilled slag (about 32,700; 45,000 tons if contaminated wetland sediments are excavated and consolidated with surface soils for final disposition).
- Excavation of on-site disposal area (450 ft long by 250 ft wide by 5 ft deep) in landfill area.
- Compaction of 6,500 CY of low-level (non-principal threat) waste material (7,600 CY if contaminated wetland sediments are excavated and consolidated with surface soil for final disposition.
- Offsite disposal of 34,335 tons of treated principal-threat waste (assuming 5% increase in volume due to treatment) in RCRA Subtitle D landfill (47,250 tons if contaminated wetlands sediment are excavated and consolidated with surface soil for final disposition).
- Installation of 1.5-ft-deep soil cushion over waste and treated material and low-level threat material capped in place (20,300 CY)
- Installation of geomembrane liner and geotextile over soil cushion (6.7 acres)
- Soil cover (1 ft deep), topsoil cover (6 inches deep), and grass seeding over site

(8 acres)

- Land use/deed restrictions and fencing

The final treatment system would depend upon the outcome of treatability testing and would be determined during the remedial design phase. The fixed material would be subjected to TCLP testing to determine if treatment has been effective, prior to placement in the excavated disposal area. Note that the components of this alternative are considered a conceptual design, but other designs may be possible. The final design would be based on requirements regarding construction in a floodplain.

Treatability testing may be required to demonstrate contaminant immobilization for this treatment process and to help determine the volume increase caused by the solidification/stabilization process.

Deed restrictions may be placed on the site while the remedial action takes place. Monitoring would be required to assess the effectiveness of the remedial action.

The topsoil layer of the cap would be graded to a minimum slope of 3% and a maximum of 5% to promote surface drainage away from the waste cell and reduce infiltration. Surface drainage controls would be constructed around the perimeter of the cap to collect surface water runoff.

Option B of Alternative 6 would eliminate direct contact with contaminated media, eliminate on-site physical hazards, minimize contaminant migration to groundwater, and eliminate contaminant migration to surface water from the site. **Figure 10-6** illustrates the components of the cap included under Alternative 6b as applied to the RM site.

fig 10-6

10.1.6.6 Effectiveness

Under Option B, principal-threat contaminated media would be treated and converted to a nonhazardous, nonleachable material and disposed offsite. Low-level threat soil located beneath the pavement would be capped in place, and other low level-threat material would be capped in the excavated landfill . Migration of hazardous contamination to groundwater would be eliminated because the treated material would be taken offsite. In addition, for low-level-threat waste capped in place, the existing clay unit would remain intact from ground surface to depths of 7 to 20 feet bgs throughout the site. The clay unit would act as a geologic barrier to isolate contaminated media and prevent its migration to groundwater. Surface water infiltration that contributes to the migration of contaminants to groundwater would be eliminated by using an impermeable geomembrane cap. Option B virtually eliminates the risks associated with the exposure pathways. Since the cap would eliminate exposure to contaminants, risk to human health is greatly reduced. Risk-based RGOs would be met above the cap, since the contaminated material is being isolated. Finally, long-term monitoring would be required to assess any potential impacts of this Option B for alternative. This combination of technologies would ensure that the selected treatment system would remediate surface soil and sediment contamination to concentrations meeting remediation goals, and RAOs would be met.

10.1.6.7 Implementability

Implementation of this alternative is considered to be technically feasible and could be accomplished through conventional construction methods. Because the site is located in a floodplain, the completion of the disposal area will need to be implemented in accordance with existing criteria and standards set forth under the National Flood Insurance Program and will need to include the use of acceptable floodproofing and/or flood protection measures. In addition, the capped area where low-level threat waste is disposed, may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities (e.g., siting) would apply to the site. Implementation factors discussed under Alternatives 2, 3, and 4 also apply to this alternative.

Treatment of the contaminated waste will likely increase the volume of the waste soil and slag material; however, slight volume reductions may occur when some chemical reagents are used to treat the material. Typical volume increases range from about 5 percent to as high as 100 percent, depending upon the treatment method used. An increase in the volume of the treated waste material will have an impact on the disposal volume required. Calculations used in the development of this alternative utilized a volume increase estimate of 5 percent.

10.1.6.8 Cost

Moderate to high costs are associated with Option B relative to other remedial alternatives. Expenditures include capital costs for equipment, construction of the cap, as well as fencing upgrades and deed restrictions, construction of the treatment system, as well as excavation. In addition, monitoring costs associated with excavation and treatment verification are realized costs. Annual and periodic O&M costs also exist and include such items as media monitoring and periodic mowing and maintenance of the cap and site.

10.2 WETLAND SEDIMENT ALTERNATIVE ANALYSIS

The alternatives that were selected for surface soil at the RM site include no action, institutional controls and off-site creation of wetlands, surface water and sediment control/diversion with off-site creation of wetlands, composting/fixation of wetlands sediment with off-site creation of wetlands, capping with off-site creation of wetlands, and excavation and grading with either clean fill or composting and revegetation.

10.2.1 ALTERNATIVE 1 -- NO ACTION

10.2.1.1 Description

Under this alternative, no remedial action would be taken with respect to the wetlands. A monitoring program would be implemented to address wetland sediments, surface water and associated uptake by biota utilizing the affected area. The monitoring program would be developed in order to allow for regulators to assess the migration of the contaminants from the wetlands and determine if remedial actions might be necessary in the future. The monitoring program would take place on a yearly basis with a risk evaluation conducted within 5 years to determine the effectiveness of this approach.

10.2.1.2 Effectiveness

The no action alternative is required by the NCP to be carried through the screening process, as it serves as a baseline for comparison of the site remedial action alternatives. This alternative does not reduce the exposure of receptors to site contaminants. Continued migration of contaminants and the resulting exposure of receptors would occur. As a result, this alternative is not effective in protecting human health or the environment, or reducing M/T/V of contaminants at the site. Monitoring proposed under this alternative would allow EPA to assess the ongoing threats to human health and the environment posed by the site.

10.2.1.3 Implementability

The only task which would require implementation under this alternative is the periodic media monitoring at the site. This alternative could be easily implemented since monitoring equipment is readily available and procedures are in place.

10.2.1.4 Cost

Minimal costs are associated with this alternative relative to other remedial action alternatives. No capital costs are associated with this alternative. Annual O&M costs for media sampling associated with monitoring exists.

10.2.2 ALTERNATIVE 2 -- INSTITUTIONAL CONTROLS AND CREATION OF WETLANDS OFF-SITE

10.2.2.1 Description

Under this alternative, fencing would be installed surrounding the wetlands to restrict access to the contaminated areas. Warning signs prohibiting the use of the area by unauthorized individuals would be posted. Inclusive of this alternative is attaining land use restrictions, deed restrictions and zoning which would prohibit activities which might disturb the site sediments. The monitoring program discussed in Alternative 1 would also be implemented under this alternative. The final component of this alternative is the creation of an off-site wetlands to mitigate the loss (due to contamination) of the RM site wetlands. The purpose of the off-site creation of wetland is to replace the functional value of the RM site wetlands where sediment is contaminated with greater than 800 mg/kg lead. As indicated in section 8.4.2, the wetlands contaminated with greater than 800 mg/kg lead encompass an area of approximate 5.7 acres. The creation of an off-site wetland under this alternative would involve the determination of the functional value of the RM site wetlands, acquisition of an appropriate type and area of land to create the offsite wetlands, and a vegetation of the offsite land to match or better the functional value of the RM site wetlands.

10.2.2.2 Effectiveness

Although an off-site wetlands would be created, this alternative does not reduce the exposure of receptors to site contaminants. Continued migration of contaminants and the resulting exposure of receptors would occur. As a result, this alternative is not effective in protecting human health or the environment, or reducing M/T/V of contaminants at the site. Monitoring proposed under this alternative would allow EPA to assess the ongoing threats to human health and the environment posed by the site.

10.2.2.3 Implementability

Implementation of this alternative is considered technically feasible and could be accomplished through conventional construction methods.

10.2.2.4 Cost

Moderate costs are associated with this alternative relative to other remedial alternatives. Major expenditures include capital costs for acquisition of and vegetating the off-site wetlands, as well as fencing upgrades and deed restrictions. Annual and periodic O&M costs also exist and include such items as media monitoring.

10.2.3 ALTERNATIVE 3 -- SURFACE WATER AND SEDIMENT CONTROL/DIVERSION AND CREATION OF WETLANDS OFF-SITE

10.2.3.1 Description

This alternative would serve to contain future discharges from the wetland area and the adjacent site properties in order to remove or reduce the spread of contamination. To accomplish surface water/sediment control, a series of embankments engineered to divert or retain water in a certain area would be developed. Sediment would then settle in ponded areas and the accumulated sediments would then be collected for treatment. Construction of conduits and flood control structures would be included in order to control contaminant migration during periods of periodic flooding. The use of vegetation to reduce sediment mobility would be investigated and may also be used. Finally, a series of diversion trenches would be developed to collect and divert surface water runoff from the contaminated wetland systems and regulate flow to control structures. Because this alternative would alter the natural grade of the wetlands, it would require off-site mitigation of the impacted wetlands area through the creation of offsite wetlands with equal or greater functional value. As with previous alternatives, a site monitoring program would be implemented.

Alternative 3 would reduce the spread of contamination by containing discharges from the wetlands area.

10.2.3.2 Effectiveness

This alternative does not remediate the existing and continuing sediment sources within the wetlands. Sediments will continue to serve as a source of contamination to surface waters and sediment toxicity would continue to pose a risk to potential receptors and the environment. Construction of containment apparatus would remobilize sediments and result in short-term risk to workers. The natural treatment and recovery of the wetlands will likely be minimal. Because the wetland area serves as a conduit of surface water to adjacent wetlands, altering the hydrology may result in increased impacts to adjacent wetlands.

10.2.3.3 Implementability

Implementation of this alternative is considered to be technically feasible and could be accomplished through conventional construction methods. However, because the site is located in a floodplain, the construction of the required components will need to be implemented in accordance with existing criteria and standards set forth under the National Flood Insurance Program and will need to include the use of acceptable floodproofing and/or flood protection measures.

10.2.3.4 <u>Cost</u>

Moderate to high costs are associated with this alternative relative to other remedial alternatives. Expenditures include capital costs for equipment, construction of the control structures, acquisition of and vegetating the off-site wetlands, as well as fencing upgrades and deed restrictions. Annual and periodic O&M costs also exist and include such items as media monitoring, surface water treatment, and sediment excavation and disposal.

10.2.4 ALTERNATIVE 4 -- COMPOSTING/FIXATION OF WETLAND SEDIMENTS AND OFF-SITE CREATION OF WETLANDS

10.2.4.1 <u>Description</u>

Alternative 4 involves the application of a layer of biosolid compost to the contaminated wetland sediment. The addition of biosolid compost limits the bioavailability of soil lead through specific adsorption and precipitation processes. In addition, the layer of biosolid compost serves as a cap covering the major sources of contamination, which would reduce the migration of contaminants from the source wetlands. One treatability study to evaluate stabilization reagents that would 1) reduce the leachibility of lead in treated wetland sediment and 2) improve the material handling qualities of the sediment so that free liquids are not released during transport or disposal was completed in March 1998 (EPA 1998)(Appendix M). The results of that study demonstrated that a biosolid product produced by N-Viro effectively reduced the leachibility of lead, absorbed free liquids and resulted in a material that could be excavated and transported for disposal. Under Alternative 4, the biosolid compost would be applied at a thickness of approximately 1 foot to the approximately 5.7 acres of wetland sediment with lead concentrations exceeding 800 mg/kg.

Surface drainage controls would be constructed around the perimeter of the cap to collect surface water runoff as appropriate. Additionally, an off-site creation of wetlands to mitigate impact to RM site wetlands is included under this alternative since the remedial action alters the natural grade of the wetlands.

Treatability testing may be required to determine optimum application rates of the biosolid compost and any required amendments to the wetlands sediment that most effectively limits bioavailability of sediment contamination.

Alternative 4 would eliminate direct contact with contaminated media, eliminate on-site physical hazards, minimize contaminant migration to groundwater, and eliminate contaminant migration to surface water from the site.

10.2.4.2 Effectiveness

The use of biosolids to restore metals contaminated land is an emerging technology with limited full scale application, although numerous bench and field scale demonstrations have demonstrated decreased bioavailability to plants and mammals. Although the alternative does not remediate existing and continuing sediment contaminant sources, risk to ecological receptors may be reduced because of the limit to bioavailability. However, risk to burrowing ecological receptors would not be reduced and would continue to pose an imminent hazard to ecological resources at the concentrations found in the wetlands.

This alternative would reduce exposure, prevent transport and migration of site contaminants and degradation of adjacent wetlands however, further degradation of the contaminated wetlands would not be achieved since grade and hydrology of the wetlands will be destroyed. To mitigate this effect, an off-site creation of wetlands is required for this remedial action.

10.2.4.3 Implementability

Implementation of this alternative is considered technically feasible and could be accomplished through conventional construction methods, although it would probably entail an added effort of finding appropriate source materials at volumes sufficient for the intended application.

If the application of the biosolid compost is considered a cap, its, the cap construction will need to be implemented in accordance with existing criteria and standards set forth under the National Flood Insurance Program and will need to include the use of acceptable floodproofing and/or flood protection measures, because the site is located in a floodplain In addition, the capped area may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities (e.g., siting) would apply to the site. Equipment, services, and personnel should be readily available from many vendors. Routine and periodic cap inspection and a maintenance program would be necessary to seal cracks and ensure that vegetation remains established.

10.2.4.4 Cost

Moderate costs are associated with this alternative relative to other remedial alternatives. Expenditures include capital costs for equipment, biosolid compost, acquisition of and vegetating the off-site wetlands, as well as fencing upgrades and deed restrictions. Annual and periodic O&M costs also exist and include such items as media monitoring.

10.2.5 ALTERNATIVE 5 -- CAPPING WITH CLEAN FILL AND OFF-SITE CREATION OF WETLANDS

10.2.5.1 Description

Capping the contaminated sediment in the wetlands at the RM site would serve to prevent rainfall infiltration and future leaching into the groundwater. In addition, capping also would limit direct contact exposure to contaminated media under the cap. Varying degrees of capping can be implemented depending on the severity of contaminants in the area. Caps can range from a simple natural soil cap to a multilayer soil/synthetic cap. For the wetlands, a foot of topsoil would be placed on the surface of the contaminated wetland sediment and graded evenly. Capping with a minimum of one foot of clean fill would be required to eliminate multiple exposure pathways as identified in the ecological risk assessment. The cap would be applied to the approximately 5.7

acres of wetlands containing sediment with lead concentrations greater than 800 mg/kg. Because this action results in a destruction of the wetlands by altering the grade and hydrology of the system, off-site creation of wetlands is required to compensate for the loss.

Alternative 5 would eliminate direct contact with contaminated media, minimize contaminant migration to groundwater, and eliminate contaminant migration. Deed restrictions may be placed on the site while the remedial action takes place. Monitoring would be required to assess the effectiveness of the remedial action.

10.2.5.2 Effectiveness

This alternative virtually eliminates the risks associated with the exposure pathways. Since the cap would eliminate exposure to contaminants, risk to ecological receptors is greatly reduced. However, organisms utilizing portions of the wetlands below the surface may potentially continue to be exposed. The cap also would limit the mobility of hazardous constituents be reducing the forces that drive the contaminants, such as infiltration of surface water in the capped area. Under this alternative, contaminant migration to groundwater is not eliminated since contaminated media remain in the ground, however, the reduction of surface water infiltration could reduce groundwater contaminant migration. Risk-based RGOs would be met above the cap, since the contaminated material is being isolated. Finally, long-term monitoring would be required to assess any potential impacts of this alternative.

10.1.5.3 Implementability

Implementation of this alternative is considered technically feasible and could be accomplished through conventional construction methods. However, because the site is located in a floodplain, the cap construction will need to be implemented in accordance with existing criteria and standards set forth under the National Flood Insurance Program and will need to include the use of acceptable floodproofing and/or flood protection measures. In addition, the capped area may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities (e.g., siting) would apply to the site. Equipment, services, and personnel should be readily available from many vendors. Routine and periodic cap inspection and a maintenance program would be necessary to seal cracks and ensure that vegetation remains established.

10.2.5.4 <u>Cost</u>

Moderate costs are associated with this alternative relative to other remedial action alternatives. Typical expenditures would include capital costs for equipment and construction of the cap, acquisition of and vegetating the off-site wetlands treatment system, as well as fencing upgrades and deed restrictions. Annual and periodic O&M costs also exist and include such items as media monitoring.

10.2.6 ALTERNATIVE 6 -- EXCAVATION & REVEGETATION/RESTORATION OF WETLANDS

OPTION A - REGRADING WITH CLEAN FILL

10.2.6.1 <u>Description</u>

Alternative 6 involves the excavation of contaminated wetland sediments to a depth of one foot, and under Option A, replacing that material with clean soils. Excavated areas will be backfilled to the existing grade and revegetated according to the Wetlands Revegetation Plan developed for the RM site wetlands (ERRT 1998)**(Appendix N)**. Maintenance plans to eliminate the intrusion of less desirable species and to promote success will be developed and site monitoring would also be required. Excavated sediments would be stockpiled with contaminated surface soils and final disposition of the contaminated wetlands sediment would follow the remedial alternative selected for surface soils. Depending on contaminated levels, excavated plant material would be consolidated with excavated sediment or mulched and disposed of separately. In excavating the approximately 5.7 acres of sediment with lead concentrations greater than 800 mg/kg to a depth of one foot; approximately 9,300 CY of contaminated sediment will be generated. Approximately 8,200 CY of the excavated sediment would be considered principal-threat waste and 1,100 CY would be considered low-level threat waste.

Treatability testing may be required to determine if pre-treatment (e.g. dewatering or stabilization) of the wetlands sediment would be required to decrease leachability of lead and improve handling characteristics of sediment prior to transport and disposal in order to implement this alternative. If pre-treatment is required, the development or selection of the process must consider the impact of the process on the wetlands community.

The revegetation of the wetlands is based on excavation of 5.7 acres where lead occurs above 800 mg/mg in sediment and which includes approximately 1.5 acres of forested and scrub/shrub wetlands. To compensate for the loss of forested and scrub/shrub wetlands; these areas will be replaced at a 2-to-1 creation-to-loss ratio. The revegetation of the wetlands is based on planting 3 acres of forested wetland and 9 acres of emergent wetlands. Forested mitigation areas would be seeded (3 lbs/acre) with a mixture of herbaceous plant species that do not form a turf and minimize competition with planted trees and shrubs. Trees and shrubs would each be planted at a density of 436 plants/acre. Emergent wetland areas would be seeded at a rate of 5 lbs/acre and planted with plugs or bare root plantings at a density of 4,840 plants/acre.

Deed restrictions may be placed on the site while the remedial action takes place. Monitoring would be required to assess the effectiveness of the remedial action.

10.2.6.2 <u>Effectiveness</u>

The removal of the contaminated sediments from the wetlands will effectively protect the environment. The removal of contaminated sediment would also reduce risk to all ecological receptors. Although short-term impacts from excavation activities will occur, these impacts will result in a net benefit considering the current wetland system presents an attractive nuisance to organisms using the contaminated area. Excavation permanently eliminates the long-term health and environmental risks at the site, as well as reducing contaminant mobility. This alternative virtually eliminates the risks associated with the exposure pathways.

10.2.6.3 Implementability

Implementation of this alternative is considered to be technically feasible and could be accomplished through conventional methods, although a moderate difficulty is posed by conducting operations in unstable sediment substrates. Wetlands restoration is a feasible and proven technology.

10.2.6.4 Cost

Moderate to high costs are associated with this alternative relative to other remedial alternatives. Expenditures include capital costs for equipment, clean fill, restoring/revegetating the wetlands, as well as fencing upgrades and deed restrictions, as well as excavation. In addition, monitoring costs associated with excavation are realized costs. Annual and periodic O&M costs also exist and include such items as media monitoring and periodic maintenance.

OPTION B - REGRADING WITH BIOSOLID COMPOST MATERIAL

10.2.6.5 Description

Option B is similar to Option A except that excavated areas would be backfilled with a biosolid compost material rather than clean fill. The compost would serve as the fill material, a metal-binding material and as a source of fertilizer to encourage revegetation/restoration. The compost material may also serve to bind contaminated groundwater should it percolate through the wetland. As with previous alternatives, a site monitoring program would be implemented.

As is the case for Option A, excavated sediments would be stockpiled with contaminated surface soils and final disposition of the contaminated wetlands sediment would follow the remedial alternative selected for surface soils. In excavating the approximately 5.7 acres of sediment with lead concentrations greater than 800 mg/kg to a depth of one foot; approximately 9,300 CY of contaminated sediment will be generated. Approximately 8,200 CY of the excavated sediment would be considered principal-threat waste and 1,100 CY would be considered low-level threat waste.

Treatability testing may be required to determine if pre-treatment (e.g. dewatering or stabilization) of the wetlands sediment would be required to decrease leachability of lead and improve handling characteristics of sediment prior to transport and disposal in order to implement this alternative as well as to confirm the value of using a biosolid backfill. If pre-treatment is required, the development or selection of the process must consider the impact of the process on the wetlands community.

Excavated areas will be backfilled to the existing grade and revegetated according to the Wetlands Revegetation Plan developed for the RM site wetlands (ERRT 1998)(Appendix N). Maintenance plans to eliminate the intrusion of less desirable species and to promote success will be developed and site monitoring would also be required. The revegetation of the wetlands is based on excavation of 5.7 acres where lead occurs above 800 mg/mg in sediment and which includes approximately 1.5 acres of forested and scrub/shrub wetlands. To compensate for the loss of forested and scrub/shrub wetlands; these areas will be replaced at a 2-to-1 creation-to-loss ratio. The revegetation of the wetlands is based on planting 3 acres of forested wetland and 9 acres of emergent wetlands. Forested mitigation areas would be seeded (3 lbs/acre) with a mixture of herbaceous plant species that do not form a turf and minimize competition with planted trees and shrubs. Trees and shrubs would each be planted at a density of 436 plants/acre. Emergent wetland areas would be seeded at a rate of 5 lbs/acre and planted with plugs or bare root plantings at a density of 4,840 plants/acre.

Deed restrictions may be placed on the site while the remedial action takes place. Monitoring would be required to assess the effectiveness of the remedial action.

10.2.6.6 Effectiveness

The removal of the contaminated sediments from the wetlands will effectively protect the environment. The removal of contaminated sediment would also reduce risk to all ecological receptors. Although short-term impacts from excavation activities will occur, these impacts will result in a net benefit considering the current wetland system presents an attractive nuisance to organisms using the contaminated area. Excavation permanently eliminates the long-term health and environmental risks at the site, as well as reducing contaminant mobility. This alternative virtually eliminates the risks associated with the exposure pathways. However, the use of biosolids to restore metals contaminated land is an emerging technology with limited full scale application, although numerous bench and field scale demonstrations have demonstrated decreased bioavailability to plants and mammals.

10.2.6.7 Implementability

Implementation of this alternative is considered to be technically feasible and could be accomplished through conventional construction methods. Because the site is located in a floodplain, the completion of the disposal area will need to be implemented in accordance with existing criteria and standards set forth under the National Flood Insurance Program and will need to include the use of acceptable floodproofing and/or flood protection measures. In addition, the capped area where low-level threat waste is disposed, may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities (e.g., siting) would apply to the site. Implementation factors discussed under Alternatives 2, 3, and 4 also apply to this alternative.

Treatment of the contaminated waste will likely increase the volume of the waste soil and slag material; however, slight volume reductions may occur when some chemical reagents are used to treat the material. Typical volume increases range from about 5 percent to as high as 100 percent, depending upon the treatment method used. An increase in the volume of the treated waste material will have an impact on the disposal volume required. Calculations used in the development of this alternative utilized a volume increase estimate of 5 percent.

10.2.6.8 Cost

Moderate to high costs are associated with this alternative relative to other remedial alternatives. Expenditures include capital costs for equipment, clean fill, restoring/revegetating the wetlands, as well as fencing upgrades and deed restrictions, as well as excavation. In addition, monitoring costs associated with excavation are realized costs. Annual and periodic O&M costs also exist and include such items as media monitoring and periodic maintenance.

10.3 GROUNDWATER ALTERNATIVE ANALYSIS

The alternatives that were selected for groundwater at the RM site include no action, limited action consisting of institutional controls and identification of a contingency alternative, capping with pavement left in place, pump and treat with physical and/or chemical treatment and discharge to either surface water or POTW, and construction of a permeable treatment bed.

10.3.1 ALTERNATIVE 1 -- NO ACTION

10.3.1.1 Description

Under this alternative, no action would be taken to remedy the contaminated groundwater at the site. The alternative would only involve the continued monitoring of groundwater at the site. Existing groundwater wells (up to 20) would be sampled for the PCOCs found in groundwater every five years for 30 years. Public health evaluations would be conducted every five years and would allow EPA to assess the ongoing risks to human health and the environment posed by the RM site. The evaluations would be based on the data collected from the media monitoring.

10.3.1.2 Effectiveness

The no action alternative is required by the NCP to be carried through the screening process, as it serves as a baseline for comparison of the site remedial action alternatives. This alternative does not reduce the exposure of receptors to site contaminants. Continued migration of contaminants and the resulting exposure of receptors would occur. As a result, this alternative is not effective in protecting human health or reducing M/T/V of contaminants at the site. Monitoring proposed under this alternative would allow EPA to assess the ongoing threats to human health and the environment posed by the site.

10.3.1.3 Implementability

The only task which would require implementation under this alternative is the periodic media monitoring at the site. This alternative could be easily implemented since monitoring equipment is readily available and procedures are in place.

10.3.1.4 Cost

Minimal costs are associated with this alternative relative to other remedial action alternatives. No capital costs are associated with this alternative. Annual O&M costs for media sampling associated with monitoring exists.

10.3.2 ALTERNATIVE 2 -- LIMITED ACTION

10.3.2.1 Description

Under the limited action alternative, no action would be taken to remediate contaminated groundwater at the site, unless a specified period of monitoring indicates that groundwater contaminant levels are not decreasing as a result of natural processes and/or activities undertaken for the remediation of soil. If monitoring indicates that levels are not decreasing sufficiently, a contingency extraction/treatment/discharge alternative could be implemented.

Alternative 2 would essentially serve as a monitored natural attenuation alternative. Natural attenuation is not a technology, but at some sites, data gathered during the RI/FS may indicate that physical or biological processes (unassisted by human intervention) may effectively reduce contaminant concentrations such that remedial objectives in the contaminant plume or certain portions of the plume are achieved in a reasonable time frame without active remediation. In some cases, remediation alternatives that combine active remediation (e.g., in source areas) with monitored natural attenuation may be appropriate. Performance monitoring is a critical component of this remediation approach because monitoring is needed to ensure that the remedy is protective and that natural processes are reducing contamination levels as expected.

Alternative 2 alternative would primarily involve implementation of institutional measures to control, limit, and monitor activities onsite. The objectives of institutional controls are to prevent prolonged exposure to contaminant concentrations, control future development, and prevent the installation of wells within the contaminated plume boundary. These objectives would be accomplished by monitoring contaminated media at the site, and limiting use and access by placing restrictions on all properties within the contaminated plume area. The effectiveness of institutional controls would depend on their continued implementation.

The alternative also would include the continued monitoring of groundwater at the site, as described under Alternative 1. Public health evaluations would be conducted every five years and would allow EPA to assess the ongoing risks to human health and the environment posed by the RM site. The evaluations would be based on the data collected from media monitoring.

10.3.2.2 Effectiveness

This alternative would be partially effective in protecting human health and the environment. However, its reliability would be dependent on future compliance with the restrictions and inspections that are enforced. The limited action alternative may help to reduce the exposure of receptors to contaminants but it does not meet all of the RAOs established for the site. Continued migration of contaminants would occur. As a result, this alternative would only be somewhat effective in protecting human health and would not be effective in reducing the M/T/V of contaminants at the site (unless contingency treatment is implemented). Monitoring proposed under this alternative would allow EPA to assess the ongoing threats to human health and the environment posed by the RM site.

The key to the effectiveness of monitored natural attenuation is the ability of natural processes to reduce contaminant concentrations to acceptable levels in a reasonable time frame. Although the limitations of the modeling should be considered carefully, the Random-Walk groundwater modeling completed as part of the EE/CA for the RM site suggest that a no action alternative for groundwater would leave lead levels well above the action level of 15 ug/l; even after 100 years. Other factors that may limit the applicability and effectiveness of the process include the need to collect data to determine model input parameters; the need for highly skilled modelers, and limiting natural attenuation to low risk situations.

10.3.2.3 Implementability

Implementation of this alternative is considered technically feasible since monitoring equipment is readily available and procedures are in place.

Treatability testing and site modeling would be required as part of the contingency treatment to determine the most effective design of the treatment system.

10.3.2.4 Cost

Unless implementation of contingency treatment of groundwater becomes necessary, the costs for implementing this alternative would be slightly higher than Alternative 1 due to additional administrative activities, however, costs would still be minimal.

10.3.3 ALTERNATIVE 3 -- CAPPING WITH PAVEMENT IN PLACE

10.3.3.1 Description

Alternative 3 is very similar to Alternative 3 for soil remediation but focuses on the protection of groundwater. Contaminated soil would be spread over the existing pavement and capped in place with the existing landfill. Alternative 3 includes the demolition of most of the on-site buildings, although the main office building would remain on site, and the landfilled slag would remain in place. Contaminated soil from areas not covered by pavement would be excavated and consolidated with the stockpiled slag and building debris. However, for the purpose of groundwater protection, offsite wetlands sediment would not be excavated and consolidated onsite. Consolidated waste material would be spread above the pavement that extends from the existing landfill to about 375 feet south of the landfill. A geosynthetic cap and underlying 1.5-ft soil cushion layer would be added above the waste and existing landfill and would cover about 6.7

acres. A 1-ft soil cover and 6-inch topsoil layer would be placed over the entire site. Components of this alternative are as follow:

- Demolition of buildings
- Excavation of contaminated soil in southeastern corner of the site (2,800 CY)
- Compaction of 8,800 CY of waste material above pavement and landfill (2,800 CY of waste soil; 6,000 CY of stockpiled slag; 1,000 CY of building debris)
- Installation of 1.5-ft-deep soil cushion over waste and existing landfill (20,300 CY)
- Installation of geomembrane liner and geotextile over soil cushion (6.7 acres)
- Soil cover (1 ft deep), topsoil cover (6 inches deep), and grass seeding over site (8 acres)

The topsoil layer of the cap would be graded to a minimum slope of 3% and a maximum of 5% to promote surface drainage away from the waste cell and reduce infiltration. Surface drainage controls would be constructed around the perimeter of the cap to collect surface water runoff.

Alternative 3 would eliminate direct contact with contaminated media, eliminate on-site physical hazards, minimize contaminant migration to groundwater, and eliminate contaminant migration to surface water from the site.

10.3.3.2 Effectiveness

Under this alternative, contaminated media would be consolidated above the existing pavement and capped above grade. The existing clay unit would remain intact from ground surface to depths of 7 to 20 feet bgs throughout the site. The clay unit would act as a geologic barrier to isolate contaminated media and prevent its migration to groundwater to a greater extent than creation of an onsite disposal area under the pavement would. Surface water infiltration that contributes to the migration of contaminants to groundwater would be eliminated by using an impermeable geomembrane cap. Long-term monitoring would be required to assess any potential impacts of this alternative.

10.3.3.3 Implementability

Implementation of this alternative is considered to be technically feasible and could be accomplished through conventional construction methods. Implementation factors discussed under Alternatives 2 and 3 for soil remediation also apply to this alternative.

10.3.3.4 Cost

Moderate costs are associated with this alternative relative to other remedial alternatives. Expenditures include capital costs for equipment , construction of the cap, as well as fencing upgrades and deed restrictions. Annual and periodic O&M costs also exist and include such items as media monitoring and periodic mowing and maintenance of the cap and site.

Capping may prove to be a cost-efficient alternative if it can be designed to effectively contain contaminated soils and limit contaminant migration to groundwater.

10.3.4 ALTERNATIVE 4 -- PUMP & TREAT W/PHYSICAL AND/OR CHEMICAL TREATMENT

10.3.4.1 Description

Alternative 4 consists of pumping groundwater from on-site extraction wells, well points, and/or subsurface drains to an on-site wastewater treatment system, and with subsequent discharge to either the City of Rossville Wastewater Treatment Plant (WWTP) or surface water. Pumping may be continuous or pulsed to allow equilibration of contaminants with the groundwater. As part of the EE/CA, four pumping scenarios were evaluated using the Well Head Protection Area

(WHPA) model presented in **Appendix K**. These scenarios (Systems A, B, C, and D) consisted of 1 to 15 groundwater extraction wells pumping at rates of 1 to 2 gpm each. The total pumping rates for these four scenarios ranged from 2 to 20 gpm. Systems A, B, and C were developed based on an interpretation of groundwater data which suggests that a single plume of lead emanates from the wrecker building area. System D was developed based on an interpretation of groundwater data that suggests that the entire site is a potential source. Groundwater modeling was used to develop the pumping systems for the site as follows:

- System A — System A consists of one extraction well discharging at 2 gpm. The well would be located near the downgradient edge of the plume associated with the wrecker building. The purpose of System A would be to contain contamination and prevent breakthrough of contaminants off site. The results of the EE/CA Random-Walk Model suggest the plume would be remediated in 11 years.

- System B — System B is identical to System A with the exception that remediation is accelerated using one additional extraction well discharging at 1 gpm located within the plume. The total discharge rate for System B is 3 gpm. The results of the EE/CA Random-Walk Model suggest the plume would be remediated in 8 years.

- System C — System C is identical to System A with the exception that remediation is accelerated using two additional extraction wells discharging at 1 gpm each located within the plume. The total discharge rate for System C is 4 gpm. The results of the EE/CA Random-Walk Model suggest the plume would be remediated in 4 years.

- System D — System D contains and remediates all groundwater associated with the Ross Metals site. Containment of groundwater is accomplished using a system of five extraction wells discharging a 2 gpm each. Remediation is accelerated using 10 additional sitewide extraction wells discharging at 1 gpm each. The total discharge rate for System D is 20 gpm. The results of the EE/CA Randow-Walk Model suggest the plume would be remediated in 7 years.

One possible treatment possibility for removing metals from groundwater involves the use of precipitation/flocculation/coagulation and sedimentation. The combination of precipitation/flocculation/coagulation and sedimentation is a well-established technology with specific operating parameters for metals removal from groundwater and surface water. Typical removal of metals employs precipitation with hydroxides, carbonates, or sulfates. Lime, soda ash, or sodium sulfide is added to water in a rapid-mixing tank along with flocculating agents such as alum, line, and various iron salts. The mixture then flows to a flocculation chamber that agglomerates particles, which are then separated from the liquid phase in a sedimentation chamber. Precipitated solids would be handled in a manner similar to contaminated soils. The supernatant would be discharged to a nearby stream or to the City of Rossville WWTP.

A second possibility for groundwater treatment involves ion exchange. Ion exchange is a process where the toxic ions are removed from the aqueous phase in an exchange with relatively harmless ions held by the ion exchange material. Modern ion exchange resins consist of synthetic organic materials containing ionic functional groups to which exchangeable ions are attached. The exchange reaction is reversible and concentration-dependent. All metallic elements, when present as soluble species, either anionic or cationic, can be removed by ion exchange.

Another process that may be used in the treatment of groundwater involves neutralization, chemical reduction, and filtration. Neutralization is an effective process for treating certain metals by altering pH thus causing metals to drop out. It is often used as a pretreatment step for other options. Chemical reduction is primarily used for treatment of wastes containing hexavalent chromium, mercury and lead. Common reducing agents include sulfur dioxide and sulfite salts, and ferrous sulfate. Finally, filtration is an effective technology when removal of low level of suspended solids is required. A significant design consideration is adequate treatment of filter backwash water which will contain high concentrations of contaminants.

Alternative 4 would reduce contaminant concentrations in groundwater to concentrations below action levels established for the site.

10.3.4.2 <u>Effectiveness</u>

Under this alternative, using the groundwater modeling completed for the EE/CA, contaminated groundwater would be pumped from 1, 2, 3, or 15 extraction wells, treated aboveground, and pumped to either the neighboring WWTP or surface water, depending on the effluent characteristics of the treated water. Migration of hazardous contamination would be eliminated because contaminated groundwater would be treated and removed from the site. The results of the EE/CA Randow-Walk Model suggest the existing groundwater contaminant plume would be removed in a 4- to 11- year time frame, depending on the scenario selected.

Successful implementation of this alternative would eliminate risks to human health and the environment and meet the removal action objectives by (1) eliminating off-site migration of contaminated groundwater and (2) reducing contaminant concentrations in groundwater to concentrations below action levels. Removal of groundwater contaminants would eliminate contaminant migration from the site.

10.3.4.3 <u>Implementability</u>

Implementation of this process option is considered technically feasible and could be readily implemented. The equipment and materials for this action are commercially available from several vendors. Treatability studies would be required to verify the unit operation's ability to perform as expected. Considerations associated with the treatment plant include the design, installation, and testing of the system; permitting requirements; and plant effectiveness verification. Monitoring of the treatment plant operation would be required to verify that the treated groundwater meets the RAOs, as well as plume cleanup verification monitoring.

The groundwater modeling results from which this alternative was developed provide a conservative estimate of the mass loading of contaminants from the vadose zone to the aquifer, the fate and transport of contaminants in the aquifer, and the potential impact on groundwater quality under a no-action scenario and various pump and treat scenarios. Because key model input parameters have been estimated and a classical calibration was not performed, the model applications are considered interpretive. In addition, the model used an overly optimistic value for retardation coefficient of lead, and as a result the modeling results indicate that the groundwater cleanup goal for lead can be achieved in 4 to 11 years. For this FS, the Random-Walk Model was re-run for each of the four pump-and-treat scenarios with a more conservative and appropriate retardation coefficient for lead. The revised model results indicate that even after 100 years, none of the pump and treat scenarios reduced groundwater lead concentrations below 115 ug/l; suggesting that it may not be possible to effectively pump and treat the existing contaminant plume to the RGO level for groundwater lead concentration.

The results of this level of monitoring cannot be used to accurately predict the future concentrations of contaminants in groundwater. A long-term aquifer test to assess aquifer characteristics and water bearing properties would be necessary to validate model results and the potential to successfully implement pump and treat remediation. Also, the vertical and lateral extent of groundwater contamination should be better defined prior to finalizing the design for a pump and treat alternative.

10.3.4.4 Cost

Moderate costs are associated with this alternative as compared with other remedial alternatives. The cost will be mostly for capital purchases, including pumps, tanks, and vessel fittings. O&M costs, including routine monitoring, will be a constant cost over the potential lifetime of the treatment plant which ranges from 4 to 11 years. Note that for comparison purposes, costs are based on treatment durations suggested by initial modeling results. However, the revised model completed for the FS suggest that treatment duration and therefore cost may be significantly longer and higher.

The requirements for discharging to the WWTP might be less stringent than the RAOs for the site, thus reducing the overall cost of this alternative.

10.3.5 ALTERNATIVE 5 - PERMEABLE TREATMENT BED

10.3.5.1 Description

Alternative 5 consists of the construction of a permeable treatment bed (or treatment wall). Treatment walls involve the construction of permanent , semi-permanent, or replaceable units across the flow path of a contaminant plume. As contaminated groundwater flows through the treatment wall, the contaminants are removed by physical, chemical and/or biological processes. These processes include precipitation, sorption, oxidation/reduction, fixation, or degradation. Because a natural gradient of groundwater flow would be used to carry contaminants through the reaction zone, a treatment wall does not require continuous input of energy. In addition, the treatment wall can degrade or immobilize contaminants in situ without the need to bring them to the surface. Furthermore, technical and regulatory considerations related to effluent discharge requirements are avoided.

Under this alternative, a trench of appropriate width would be excavated to intercept the contaminated strata and backfilled with reactive material. Potential candidates for a reactive material than can successfully treat lead contamination in groundwater include limestone, zeolites, modified zeolites, and hydroxyapatite. The limestone and hydroxyapatite work by precipitating the lead from groundwater while the zeolites work by sorbing the lead.

Additional site characterization is included under this alternative as additional data is needed to assess the potential applicability of treatment wall technology for the RM site and involves hydrological, geological, and geochemical descriptions of the site as well as contaminant properties and distribution.

Construction of a treatment wall at the RM site may be an effective mechanism to prevent further migration of a contaminant plume. If placed immediately downgradient of a contaminant source, a treatment wall may effectively prevent plume formation.

10.3.5.2 Effectiveness

Laboratory studies suggest that treatment walls may potentially be effective in removing lead contamination from groundwater. Ma et. al (1993, 1994) found that hydroxyapatite reduced initial lead concentrations of 5 - 500 mg/l to 0.18 - 19.7 ug/l. Aqueous lead in lead-contaminated soil materials was reduced from 2273 ug/l to 36 ug/l. The immobilization process was rapid and near completion in 30 minutes. The study suggested that lead immobilization required hydroxyapatite [$Ca_{10}(PO_4)_6(OH)_2$] dissolution with subsequent precipitation of hydroxypyromorphite [$Pb_{10}(PO_4)_6(OH)_2$]. The study also indicated that effective lead immobilization with apatites (phosphate minerals) was accomplished only when the solution pH was low enough (5-6) to dissolve the apatite and supply phosphorous to react with lead, but still high enough to keep the solubility of hydroxypyromorphite low. Finally, the study noted that the presence of various other metals in solution inhibited lead immobilization through precipitation of metal phosphates, thereby decreasing the amount of dissolved phosphorous available for precipitation with dissolved ions.

In other studies, Haggerty and Bowman (1993) and Bowman et al. (1994) evaluated the possibility of using zeolites treated with quaternary amines for removal of arsenic, cadmium, chromium, and lead from a contaminated groundwater. Unmodified zeolites sorbed lead from solution, while surfactant-modified zeolites also sorbed chromate, selenate, and sulfate.

Another possibility for a reactive media in the treatment wall is limestone. Limestone, which has been used to address acid mine drainage (GWRTAC 1996) is being used in a treatment wall-based remediation at the Tonolli Corporation Site and Brown's Battery Breaking Site, both in Pennsylvania, to treat lead contamination in groundwater (EPA 1994).

10.3.5.3 Implementability

Once concern with treatment wall technology is the question of long-term performance under variable conditions that are typically associated with contaminated groundwater such as seasonal variations in groundwater flow velocity and patterns and variations in contaminant speciation and concentration. Potential considerations that should be addressed in the implementation of a treatment wall remedial action include:

- sufficient characterization of site geology, hydrology, contaminant distribution and vectors impacting human health and the environment to permit adequate design;
- ability of the design to account for uncertainties in subsurface investigations and treatments;
- ability of the design to capture and adequately remediate both the vertical and horizontal extent of the groundwater plume; and
- monitoring to measure concentrations of by-products potentially produced through treatment wall reactions, potential releases of gaseous by-products, as well as to characterize precipitate formation and wall clogging that may limit the effectiveness of the treatment method.

According to a Ground-Water Remediation Technologies Analysis Center Technology Evaluation report, there is a general need to establish tested and proven design procedures and protocols for treatment wall technology, particularly better predictive models that can assist in determining optimal location and sizing of the wall (GWRTAC 1996).

10.3.5.4 Cost

A principal advantage of permeable treatment wall technology over other groundwater remediation approaches is the reduced O&M costs. Other than groundwater monitoring, the major factor affecting operating and maintenance costs is the need for periodic removal of precipitates from the reactive media or periodic replacement/rejuvenation of the affected sections of the wall. Capital costs for treatment walls that have been constructed range from low to moderate.

10.4 SCREENING OF SURFACE SOIL ALTERNATIVES FOR FURTHER EVALUATION

10.4.1 EFFECTIVENESS

Alternatives 1 is not effective in achieving any of the RAOs. Alternatives 2, 3, 4 and 6 can partially meet RAOs by reducing risks associated with exposure pathways; however, at least some contaminated material still remains onsite. Alternative 5 is potentially effective in achieving RAOs.

10.4.2 IMPLEMENTABILITY

All of the alternatives are implementable. Alternative 1 is easiest to implement, followed by Alternatives 2, 3, 4, 6, and 5. Option B for both Alternatives 5 and 6 is dependent on finding a landfill willing to accept the treated material. The implementability of Alternatives 2, 3, 4, and Option A of Alternatives 5 and 6 are highly dependent on the acceptability by the state and community.

10.4.3 COST

Alternative 1 is the least costly of all of the alternatives, followed by Alternatives 2, 4 and 3, Option B of Alternatives 6 and 5, and Option A of Alternatives 6 and 5.

10.5 SCREENING OF SURFACE WETLAND SEDIMENT ALTERNATIVES FOR FURTHER EVALUATION

10.5.1 EFFECTIVENESS

Alternatives 1 is not effective in achieving any of the RAOs. Alternatives 2, 3, 4 and 5 can partially meet RAOs by reducing risks associated with exposure pathways; however, at least some contaminated material still remains onsite. Alternative 6 is potentially effective in achieving RAOs.

10.5.2 IMPLEMENTABILITY

All of the alternatives are implementable. Alternative 1 is easiest to implement, followed by Alternatives 2, 5, 4, 6, and 3.

10.5.3 COST

Alternative 1 is the least costly of all of the alternatives, followed by Alternatives 2, 6, 4, 5 and 3.

10.6 SCREENING OF GROUNDWATER ALTERNATIVES FOR FURTHER EVALUATION

10.6.1 EFFECTIVENESS

Alternatives 1 and 2 are not effective in achieving any of the RAOs, although Alternative 2 may be partially effective in achieving RAOs if completed along with a source remediation. Alternative 3 also would be partially effective in meeting RAOs although groundwater contamination would not be treated.   Alternatives 4 and 5 are effective for treatment of groundwater.

10.6.2 IMPLEMENTABILITY

All of the alternatives are implementable. Alternative 1 and 2 are the easiest to implement, followed by Alternatives 3, 5 and 4. Implementability of Alternatives 4 and 5 are heavily dependent on the completion of a long-term aquifer test to assess aquifer characteristics and water bearing properties to validate model results and the potential to successfully implement pump and treat remediation. Also, the vertical and lateral extent of groundwater contamination should be better defined prior to finalizing the design for a pump and treat or treatment wall alternative.

10.6.3 COST

Alternative 1 is the least costly of all of the alternatives, followed by Alternative 2. Alternative 3 should be less expensive than Alternatives 4 and 5, especially if completed as part of a soil remediation effort. With the exception of Alternative 1, all of the alternatives require the completion of additional groundwater modeling, and as necessary, treatability tests, to design an effective remediation system.

10.7 SELECTION OF ALTERNATIVES FOR FURTHER EVALUATION

10.7.1 SURFACE SOIL ALTERNATIVES

Alternative 1 (No Action) is retained for detailed analysis as required by the NCP. This alternative serves as a baseline for decision makers to evaluate the other alternatives.

Although contaminated media would remain on site, Alternatives 2 (Capping), 3 (Capping with pavement in place), 4 (Capping with construction of above-ground disposal cell) and 6 (Capping with excavation and onsite treatment of principal threat waste) are retained since exposure would be greatly minimized and migration of contaminants to groundwater also would be restricted.

Alternatives 5 (Excavation and Onsite Treatment with Solidification/Stabilization and Onsite Offsite Disposal) is retained for further consideration since it can achieve RAOs through treatment.

10.7.2 WETLAND SEDIMENT ALTERNATIVES

Alternative 1 (No Action) is retained for detailed analysis as required by the NCP. This alternative serves as a baseline for decision makers to evaluate the other alternatives.

Alternative 2 (Institutional Controls and Off-site Creation of Wetlands) is eliminated from further consideration as it fails to address the contamination in the wetlands nor reduce risk to ecological receptors.

Alternative 3 (Surface Water and Sediment Control/Diversion and Off-site Creation of Wetlands) is eliminated from further consideration as risk to ecological receptors is not reduced and will continue to pose an imminent hazard to ecological resources at the concentrations found in the environment.

Of the two alternatives involving capping; Alternative 4 (Capping with Biosolid Compost and Off-site Creation of Wetlands) is eliminated from further consideration because there is limited data regarding full scale application of the technology, while Alternative 5 (Capping with Clean Fill and Off-site Creation of Wetlands), which is retained, achieves many of the same RAOs with a traditional, readily implementable technology.

Finally, Alternative 6 (Excavation and Revegetation/Restoration of the Wetlands) is retained for further consideration since contamination is removed from the wetlands, eliminating risk to ecological receptors and the functional value of the wetlands is restored.

10.7.3 GROUNDWATER ALTERNATIVES

Alternative 1 (No Action) is retained for detailed analysis as required by the NCP. This alternative serves as a baseline for decision makers to evaluate the other alternatives.

Alternative 2 (Limited Action) is retained for further consideration since it includes development of a contingency alternative, which may be required should additional field and modeling efforts indicate that pumping of the contaminated groundwater may not be effective.

Although modeling results indicate that it would be effective in preventing future groundwater contamination (via the elimination of surface water infiltration), Alternative 3 (Capping) is eliminated from further consideration because it does not remediate the existing groundwater plume.

Alternative 4 (Pump & Treat with Physical and/or Chemical Treatment) is retained for further consideration as it is applicable to a wide range of metals.

Finally, Alternative 5 is not retained for further consideration because of implementation considerations.

11.0 DETAILED ANALYSIS OF ALTERNATIVES

For surface soil, all six alternatives were carried through the screening process presented in Section 10.0. These are:

- Alternative 1 No Action
- Alternative 2 Capping
- Alternative 3 Capping with Pavement in Place
- Alternative 4 Capping with Construction of Above-Ground Disposal Cell
- Alternative 5 A/B Excavation and Onsite Treatment with Solidification/Stabilization
- Alternative 6 A/B Capping with Excavation and Onsite Treatment of Principal Threat Waste

For wetland sediment, three alternatives were carried through the screening process. Renumbered, they are:

- Alternative 1 No Action
- Alternative 2 Capping with Clean Fill and Off-site Creation of Wetlands
- Alternative 3 A/B Excavation and Revegetation/Restoration of Wetlands

For groundwater, three alternatives were carried through the screening process. Renumbered, they are:

- Alternative 1 No Action
- Alternative 2 Limited Action
- Alternative 3 A/B/C/D Pump & Treat With Physical and/or Chemical Treatment

Those alternatives not selected may be reconsidered at a later step during the remedial design phase if information is developed that identified an additional advantage not previously apparent, or as an alternative for a similar retained alternative that continues to be evaluated favorably.

In accordance with the NCP, the retained alternatives described in Section 10.0 were evaluated against the nine criteria as described below.

Overall Protection of Human Health and the Environment

Each alternative was assessed to determine whether it can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposures to levels established during development of remediation goals. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Compliance with ARARs

Each alternative was assessed to determine whether it will attain ARARs under federal and state environmental or facility siting laws, or provide grounds for invoking one of the waivers.

Long-Term Effectiveness and Permanence

Each alternative was assessed for the long-term effectiveness and permanence it presents, along with the degree of certainty that the alternative will prove successful. Factors considered as appropriate included the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their M/T/V and propensity to bioaccumulate.

- Adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste. This factor addresses the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative; and the potential exposure pathways and risks posed should the remedial action need replacement.

Reduction of M/T/V Through Treatment

The degree to which each alternative employs recycling or treatment that reduces M/T/V was assessed, including how treatment is used to address the principal threats posed by the site. Factors considered as appropriate included the following:

- the treatment or recycling processes the alternatives employ and the materials they will treat;
- the amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled;
- the degree of expected reduction of M/T/V of the waste due to treatment or recycling and the specification of which reduction(s) are occurring;
- the degree to which the treatment is irreversible;
- the type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccummulate such hazardous substances and their constituents; and
- the degree to which treatment reduces the inherent hazards posed by principal threats at the site.

Short-Term Effectiveness

The short-term effectiveness of each alternative were assessed considering the following:

- short-term risks that might be posed to the community during implementation of an alternative;
- potential impacts on workers during remedial action and the effectiveness and reliability of protective measures;
- potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and
- time until protection is achieved.

Implementability

The ease or difficulty of implementing each alternative was assessed by considering the following types of factors as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (e.g. offsite disposal).

- Availability of services and materials, including the availability of adequate offsite treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies.

Cost

The types of costs that were assessed include the following:

- Capital costs, including both direct and indirect costs;
- Annual O&M; and
- Net present worth of capital and O&M costs.

The present worth of each alternative provides the basis for the cost comparison. The present worth cost represents the amount of money that, if invested in the initial year of the remedial action at a given rate, would provide the funds required to make future payments to cover all costs associated with the remedial action over its planned life.

The present worth analysis was performed on all remedial alternatives using a 7% discount rate over a period of 30 years. Inflation and depreciation were not considered in preparing the present worth costs. **Appendix O** contains spreadsheets showing each component of the present worth costs.

State Acceptance

Assessment of State concerns will not be completed until comments on the RI/FS report are received but may be discussed, to the extent possible, in the proposed plan issued for public comment. The State concerns that shall be assessed include the following:

- the State’s position and key concerns related to the preferred alternative and other alternatives, particularly, the State's as well as the U.S. Fish and Wildlife Service's concerns regarding the proposed destruction and revegetation of wetlands; and
- State comments on ARARs or the proposed use of waivers.

Community Acceptance

This assessment includes determining which components of the alternatives interested persons in the community support, have reservations about, or categorically reject. This assessment will not be completed until comments on the proposed plan are received.

11.1 ANALYSIS OF ALTERNATIVES

In order to establish priority among these criteria, they are separated into three groups. The first two criteria listed are threshold criteria, and must be satisfied by the remedial action alternative being considered. The next five criteria are secondary criteria used as balancing criteria among those alternatives which satisfy the threshold criteria. The last two criteria are not evaluated during the FS. State and community acceptance is evaluated by EPA during the public comment period of the proposed plan, and an EPA responsiveness summary is incorporated into the Record of Decision. The objective of this section is to evaluate each of the alternatives for site remediation, individually on the basis of the threshold and balancing criteria. A summary of this analysis is presented in **Tables 11-1 through 11-3**. A comparative analysis of how the seven criteria are satisfied by each of the alternatives is presented in Section 12.0.

11.1.1.1 Alternative 1 -- No Action

Overall Protection of Human Health and the Environment

The no action alternative does not eliminate any exposure pathways or reduce the level of risk of the existing soil contamination.

Compliance with ARARs

This alternative does not achieve the RAOs or chemical-specific ARARs established for surface soil. Location- and action-specific ARARs do not apply to this alternative since further remedial actions will not be conducted.

Long-Term Effectiveness and Permanence

The remediation goals derived for protection of human health and the environment would not be met. Because contaminated soil remains under this alternative, a review/reassessment of the conditions at the site would be performed at 5-year intervals to ensure that the remedy does not become a greater risk to human health and the environment.

Table 11-1

Summary of Soil Alternatives Evaluation
Ross Metals Site
Rossville, Tennessee

Remedial Alternative	Threshold Criteria		Balancing Criteria					
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability		Cost Approx. Total Present Worth
						Technical/Engineering Considerations	Estimated Time for Implementation (years)	
1 -- No Action	Does not eliminate exposure pathways or reduce the level of risk. Does not limit migration of or remove contaminants.	Chemical-specific ARARs are not met. Location- and action-specific ARARs do not apply.	The contaminated material is a long-term impact. The remediation goals are not met.	No reduction of M/T/V is realized.	Level D protective equipment is required during sampling.	None	<1	$100,247
2 -- Capping	Eliminates exposure pathways and reduces the level of risk. Isolates contamination and minimizes further migration.	All action-specific ARARs are expected to be met. Location-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with surface soil and sediment are greatly reduced. No residual risks from the alternative. Long - term effectiveness requires cap maintenance	Reduction of mobility is realized but contaminant volume or toxicity are not reduced. For the principal threat waste at the site, does not meet EPA's expectation to treat principal threat waste.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain.	<1	Opt.1-$1,735,804 Opt.2-$1,712,412
3 -- Capping With Pavement In Place	Eliminates exposure pathways and reduces the level of risk. Isolates contamination and minimizes further migration.	All action-specific ARARs are expected to be met. Location-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with surface soil and sediment are greatly reduced. No residual risks from the alternative. Long - term effectiveness requires cap maintenance	Reduction of mobility is realized but contaminant volume or toxicity are not reduced. For the principal threat waste at the site, does not meet EPA's expectation to treat principal threat waste.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain.	<1	Opt.1-$1,453,803 Opt.2-$1,430,411
4 -- Capping With Construction of Above-Ground Disposal Cell	Eliminates exposure pathways and reduces the level of risk. Isolates contamination and minimizes further migration.	All action-specific ARARs are expected to be met. Location-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with surface soil and sediment are greatly reduced. No residual risks from the alternative. Long - term effectiveness requires cap maintenance	Reduction of mobility is realized but contaminant volume or toxicity are not reduced. For the principal threat waste at the site, does not meet EPA's expectation to treat principal threat waste.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain.	<1	Opt.1-$1,506,847 Opt.2-$1,481,865

Note: Option 1 includes excavated wetland sediment; Option 2 does not.

Table 11-1(cont)

Remedial Alternative	Threshold Criteria		Balancing Criteria					
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability		Cost Approx. Total Present Worth
						Technical/Engineering Considerations	Estimated Time for Implementation (years)	
5A -- Excavation and Onsite Treatment With Solidification/ Stabilization and Onsite Disposal	Eliminates exposure pathways and reduces the level of risk. Immobilizes contamination and eliminates further migration.	Chemical-specific ARARs are met. Location- and action-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with surface soil and sediment are eliminated. No residual risks from the alternative. Requires effective cap maintenance.	Mobility and toxicity are reduced, however, treatment process will increase volume. Meets EPA expectation to treat principal threat waste, but also treats (rather than contains) low-level threat wastes.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain.	<1	Opt.1- $4,907,274 Opt.2-$4,244,992
5B -- Excavation and Onsite Treatment With Solidification/ Stabilization and Offsite Disposal	Eliminates exposure pathways and greatly reduces the level of risk. Removes contamination and mitigates further migration.	ARARs are met through onsite treatment and offsite disposal.	Long-term public health threats associated with surface soil and sediment are eliminated. No residual risks from the alternative.	Mobility and toxicity are reduced, however, treatment process will increase volume. Meets EPA expectation to treat principal threat waste, but also treats (rather than contains) low-level threat wastes.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	None	<1	Opt.1-$7,477,199 Opt.2-$6,181,160
6A -- Capping With Excavation and Onsite Treatment And Disposal Of Principal-Threat Waste	Eliminates exposure pathways and greatly reduces the level of risk. Removes contamination and mitigates further migration.	Chemical-specific ARARs are met. Location- and action-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with surface soil and sediment are eliminated. No residual risks from the alternative. Requires effective cap maintenance.	Mobility and toxicity are reduced, however, treatment process will increase volume. Meets EPA expectation to treat principal-threat waste and contain low-level threat waste.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain.	<1	Opt.1-$3,175,137 Opt.2-$2,729,543
6B -- Capping With Excavation and Onsite Treatment And Offsite Disposal Of Treated Principal-Threat Waste	Eliminates exposure pathways and greatly reduces the level of risk. Removes contamination and mitigates further migration.	Chemical-specific ARARs are met. Location- and action-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with surface soil and sediment are eliminated. No residual risks from the alternative. Requires effective cap maintenance.	Mobility and toxicity are reduced, however, treatment process will increase volume. Meets EPA expectation to treat principal-threat waste and contain low-level threat waste.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain	<1	Opt.1-$4,936,044 Opt.2-$4,013,508

Note: Option 1 includes excavated wetland sediment; Option 2 does not.

Table 11-2

Summary of Wetland Sediment Alternatives Evaluation
Ross Metals Site
Rossville, Tennessee

Remedial Alternative	Threshold Criteria		Balancing Criteria					
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability		Cost Approx. Total Present Worth
						Technical/Engineering Considerations	Estimated Time for Implementation (years)	
1 -- No Action	Does not eliminate exposure pathways or reduce the level of risk. Does not limit migration of or remove contaminants.	Chemical-specific ARARs are not met. Location- and action-specific ARARs do not apply.	The contaminated material is a long-term impact. The remediation goals are not met.	No reduction of M/T/V is realized.	Level D protective equipment is required during sampling.	None	<1	$100,247
2 -- Capping w/Clean Fill and Off-site Creation of Wetlands	Potentially eliminates multiple exposure pathways to ecological receptors. Organisms utilizing portions of the wetlands below the surface may potentially continue to be exposed.	Does not meet ARARS for protection of wetlands.	Will reduce or eliminate viable exposure pathways and prevent degradation of adjacent wetlands No residual risks from the alternative. Long -term effectiveness requires cap maintenance	Reduction of mobility is realized but contaminant volume or toxicity are not reduced. For the principal threat waste at the site, does not meet EPA's expectation to treat principal threat waste.	Level C and D protective equipment required during site activities. Grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Capping in a floodplain and wetlands.	<1	$611,762
3 A -- Excavation and Revegetation/ Restoration of Wetlands and Regrading with Clean Fill	Eliminates exposure pathways and reduces the level of risk. Removes contamination and restores functional value of contaminated wetlands.	All action-specific ARARs are expected to be met. Location-specific ARARs are applicable and would need to be met.	Long-term ecological threats associated with sediment are greatly reduced. No residual risks from the alternative. Long -term effectiveness requires cap maintenance	Reduction of mobility, toxicity, and volume is achieved through removal, not treatment.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Short-term impacts to the wetlands from excavating activities will occur.	None	<1	$780,071
3 B -- Excavation and Revegetation/ Restoration of Wetlands and Regrading with Biosolid Compost	Eliminates exposure pathways and reduces the level of risk. Removes contamination and restores functional value of contaminated wetlands.	All action-specific ARARs are expected to be met. Location-specific ARARs are applicable and would need to be met.	Long-term ecological threats associated with sediment are greatly reduced. No residual risks from the alternative. Long -term effectiveness requires cap maintenance	Reduction of mobility, toxicity,and volume is achieved through removal, not treatment. Additionally, use of biosolid compost reduces toxicity by limiting bioavailability of contaminants.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Short-term impacts to the wetlands from excavating activities will occur.	None.	<1	$699,548

Table 11-3
Summary of Groundwater Alternatives Evaluation
Ross Metals Site
Rossville, Tennessee

Remedial Alternative	Threshold Criteria		Balancing Criteria					
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability		Cost Approx. Total Present Worth
						Technical/Engineering Considerations	Estimated Time for Implementation (years)	
1 -- No Action	Does not eliminate exposure pathways or reduce the level of risk. Does not limit migration of or remove contaminants.	Chemical-specific ARARs are not met. Location- and action-specific ARARs do not apply.	The contaminated groundwater is a long-term impact. The remediation goals and MCLs are not met.	No reduction of M/T/V is realized.	Level D protective equipment is required during sampling.	None	<1	$86,597
2 -- Limited Action	Unless contingency component is implemented, does not eliminate exposure pathways. Minimally reduces the level of risk.	Chemical-specific ARARs are not met. Location- and action-specific ARARs do not apply unless contingency component is implemented.	The contaminated groundwater is a long-term impact. The remediation goals and MCLs are not met.	No reduction of M/T/V is realized, unless contingency component is implemented.	Level D protective equipment is required during sampling.	Additional data collection needed to determine aquifer characteristics and vertical extent of contamination. Treatability study may be needed to develop contingency treatment component.	<1	$498,095
3 -- Pump & Treat With Physical and/or Chemical Treatment	Eliminates exposure pathways and reduces the level of risk. Reduces contamination and eliminates further migration.	Chemical-specific ARARs are met. Location- and action-specific ARARs are applicable and would need to be met.	Long-term public health threats associated with groundwater are eliminated. No residual risks from the alternative.	Mobility ,toxicity and volume are reduced.	Level C and D protective equipment required during site activities. Excavating and grading may result in potential release of dust. Noise nuisance from use of heavy equipment.	Additional data collection required to determine aquifer characteristics and vertical extent of contamination. Treatability study may be needed to define treatment component.	5-12	A -- $1,359,116 B -- $1,185,719 C -- $867,484 D -- $1,652,450

Note: Scenarios A,B, C, and D refer to four different extraction system setups.

Reduction of M/T/V Through Treatment

No reductions in contaminants M/T/V are realized under this alternative.

Short-Term Effectiveness

Since no further remedial action would be implemented at this site, this alternative poses no short-term risks to onsite workers. It is assumed that Level D personnel protection would be used when sampling various media.

Implementability

This alternative could be implemented immediately since monitoring equipment is readily available and procedures are in place.

11.1.1.2 Alternative 2 -- Capping

Overall Protection of Human Health and the Environment

Successful implementation of this alternative would reduce risks to human health and the environment and meet the removal action objectives by (1) eliminating exposure of residents and trespassers to waste material by direct contact and airborne migration, (2) eliminating exposure of trespassers to direct contact with on-site physical hazards, and (3) minimizing the migration of contaminants to groundwater and eliminating the migration of contaminants to surface water. Consolidation and isolation of the waste material beneath a geomembrane cap would eliminate receptor routes of exposure through ingestion and inhalation. Structures throughout the site would be demolished and disposed of in an excavated disposal area beneath the existing pavement. As a result, physical hazards associated with deteriorating structures would be eliminated. In addition, geomembrane capping would eliminate infiltration of precipitation and surface water that contributes to the migration of contaminants to groundwater. However, because the waste material will remain on site, contaminant migration to groundwater cannot be discounted as an adverse effect. Nevertheless, the elimination of surface water infiltration makes this scenario unlikely, and contaminant migration through surface water runoff to the adjacent wetlands and the Wolf River would be eliminated.

The threat of direct human exposure to contaminated waste and physical hazards would be practically eliminated by this alternative; however, the threat could return over the long term if cap integrity was compromised. The potential for ingestion, dermal contact, and inhalation of soil containing metals would be eliminated by successfully placing the geomembrane cap over the waste material.

Compliance with ARARs

The RCRA hazardous waste disposal facility requirements are potentially applicable. The RM site is located in a 100-year floodplain within a zone designated as A3, indicating that base flood elevations and flood hazard factors have been determined for this area. The ARAR (40 CFR 264) requires that disposal facilities be designed to withstand a 100-year flood. In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. Specifically, when it is apparent that a proposed or potential Agency action is likely to impact a floodplain or wetlands, the public should be informed through appropriate public notice processes. Furthermore, if a proposed action is located in or affects a floodplain or wetlands, a floodplain/wetlands assessment shall be undertaken, and a statement of findings explaining why the proposed action must be located in or affect the floodplain or wetlands.

Regarding construction activities related to implementing the alternative, 40 CFR 6 Appendix A requires that EPA-controlled structures and facilities must be constructed in accordance with

existing criteria and standards set forth under the NFIP and must include mitigation of adverse impacts wherever feasible, including the use of accepted floodproofing and/or other flood protection measures. To achieve flood protection, EPA shall wherever practicable, elevate structures above the base flood level rather than filling land. In addition, the capped area may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities (e.g., siting) would apply to the site. The SWPD rule (Rule 1200-1-7) and the Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR 257) require that disposal facilities must not be located in a 100-year floodplain, unless both of the following can be demonstrated:

- Location in the floodplain will not restrict the flow of the 100-year flood nor reduce the temporary water storage capacity of the floodplain

- The facility is designed, constructed, operated, and maintained to prevent washout of any solid waste

Wetlands are located to the north and northeast of the facility and landfill, although these locations are not identified on NWI maps. The Protection of Wetlands Order (40 CFR 6) requires that no adverse impacts to wetlands result from a remedial action. With appropriate stormwater runon and runoff controls, the substantive requirements of this ARAR are expected to be met. The SWPD rule requires that new landfills and lateral expansions shall not be located in a wetlands, unless the owner or operator can make the following demonstrations:

- the presumption of a practicable alternative that does not involve wetlands is clearly rebutted,

- the construction/operation of the landfill will not cause or contribute to violations of applicable State water quality standards, any applicable toxic effluent standard or prohibition under Section 307 of the CWA, and will not cause or contribute to the taking of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of endangered or threatened species,

- the landfill will not cause or contribute to significant degradation of wetlands,

- to the extent required under Section 404 of the CWA or Tennessee Water Pollution Control Act, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function), and

- sufficient information is available to make a reasonable determination with respect to these demonstrations.

The substantive requirements for stormwater discharges during construction activities as outlined by the CWA are relevant and appropriate. However, a specific NPDES permit is not required for this remedial action.

All action-specific ARARs are expected to be met. The TAPCR dust suppression and control requirements (Rule 1200-3-8) apply to earth-moving activities associated with this alternative. ARARs for the control of fugitive dust emissions would be met by applying water to roads receiving heavy vehicular traffic and to excavation areas, as necessary.

Long-Term Effectiveness and Permanence

Under this alternative, the cap would have to be maintained to ensure that it continues to perform as designed; consequently, long-term monitoring, inspection, and maintenance would be required. The cap would be susceptible to settlement, ponding of surface water, erosion, and disruption of cover integrity by deep-rooting vegetation and burrowing animals. The cover would need to be periodically inspected, and required maintenance would need to be implemented in order to maintain effectiveness.

The long-term effectiveness of capping the waste would be enhanced by selecting the proper cover design and grading layout. In addition, access restrictions such as land use controls and fencing would be required to prevent land uses incompatible with the site; specifically, land uses that would compromise the cap should be precluded.

Reduction of M/T/V Through Treatment

The primary objective of this alternative is to reduce contaminant mobility by isolating contaminants from receptor contact; contaminant volume or toxicity would not be reduced. Contaminant mobility would be reduced by installing an impermeable cap liner. The liner would eliminate surface water or precipitation infiltration and would greatly reduce contaminant migration to groundwater in conjunction with the existing clay unit beneath the site. Consolidation and capping would isolate waste source areas and would reduce contaminant mobility resulting from surface water transport and wind erosion. Contaminant mobility is expected to be reduced to an extent that would result in overall risk reduction from all pathways and exposure routes.

This alternative would not meet EPA's expectation to use treatment to address the principal threats posed by a site, although in some situations, containment of principal threats is warranted (EPA 1991). Based on sample results collected during previous site investigations, 600 CY of surface soil and 16,000 CY of stockpiled and landfilled slag would be considered "principal-threat" waste.

Containment of principal threats may be warranted where treatment technologies are not technically feasible or available within a reasonable time frame; or where the volume of materials or complexity of the site makes implementation of treatment technologies infeasible; or where implementation of a treatment-based remedy would result in greater overall risk to human health and the environment or cause severe effects across environmental media. A review of currently available technologies and site conditions does not suggest that these situations would apply to the RM site.

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short term and minimal. Short-term impacts are associated with excavation and consolidation of waste soil and slag; however, these potential, short-term impacts would be mitigated during the construction phase.

If the excavated material is dry, on-site workers will be exposed to waste soil and slag dust during excavation and consolidation activities. Additional exposure to lead dust may occur during the demolition of building structures and pavement. Ingestion of dust could involve some health effects because of the high level of metals in waste soil and slag.

On-site workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur during waste consolidation and grading. Dust emissions would be monitored at the property boundaries. Fugitive dust emissions would be controlled by applying water as needed to surfaces receiving heavy vehicular traffic or in excavation areas. A measurable, short-term impact to the surrounding area would include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Implementability

Construction of a geomembrane surface cap is a standard construction practice. Other than the capping of contaminated material in a floodplain, no significant construction issues are expected to be encountered.

No state or federal permits are expected to be required; however, advance consultation should occur while planning the action to ensure that all involved agencies are allowed to provide input.

All services and materials for this alternative are readily available.

Cost

The total present worth for Alternative 2 is approximately $1,735,804 for Option 1, which includes the excavated wetlands sediment, and $1,712,412 for Option 2, which does not include the wetland sediment. For Option 1, the estimated capital cost is approximately $1,575,908, and the estimated O&M cost is approximately $159,895. For Option 2, the estimated capital cost is approximately $1,552,516, and the estimated O&M cost is approximately $159,895.Detailed cost estimates are in Appendix O.

11.1.1.3 <u>Alternative 3 -- Capping With Pavement In Place</u>

Overall Protection of Human Health and the Environment

Successful implementation of this alternative would reduce risks to human health and the environment and meet the removal action objectives by (1) eliminating exposure of residents and trespassers to waste material by direct contact and airborne migration, (2) eliminating exposure of trespassers to direct contact with on-site physical hazards, and (3) further reduce the migration of contaminants to groundwater over Alternative 2 and eliminate the migration of contaminants to surface water. Consolidation and isolation of the waste material beneath a geomembrane cap would eliminate receptor routes of exposure through ingestion and inhalation. Structures throughout the site would be demolished and disposed of in the disposal area above the existing pavement and landfill area. The waste material would be spread and compacted throughout the site. Physical hazards associated with deteriorating structures would be eliminated. In addition, geomembrane capping would eliminate infiltration of precipitation and surface water that contributes to the migration of contaminants to groundwater. However, because the waste material will remain on site, contaminant migration to groundwater cannot be discounted as an adverse effect. Nevertheless, the elimination of surface water infiltration makes this scenario unlikely, and contaminant migration through surface water runoff to the adjacent wetlands and the Wolf River would be eliminated.

The threat of direct human exposure to contaminated waste and physical hazards would be practically eliminated by this alternative; however, the threat could return over the long term if cap integrity was compromised. The potential for ingestion, dermal contact, and inhalation of soil containing metals would be eliminated by successfully placing the geomembrane cap over the waste material.

Compliance with ARARs

The RCRA hazardous waste disposal facility requirements are potentially applicable. The RM site is located in a 100-year floodplain within a zone designated as A3, indicating that base flood elevations and flood hazard factors have been determined for this area. The ARAR (40 CFR 264) requires that disposal facilities be designed to withstand a 100-year flood. In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. Specifically, when it is apparent that a proposed or potential Agency action is likely to impact a floodplain or wetlands, the public should be informed through appropriate public notice processes. Furthermore, if a proposed action is located in or affects a floodplain or wetlands, a floodplain/wetlands assessment shall be undertaken, and a statement of findings explaining why the proposed action must be located in or affect the floodplain or wetlands.

Regarding construction activities related to implementing the alternative, 40 CFR 6 Appendix A requires that EPA-controlled structures and facilities must be constructed in accordance with

existing criteria and standards set forth under the NFIP and must include mitigation of adverse impacts wherever feasible, including the use of accepted floodproofing and/or other flood protection measures. To achieve flood protection, EPA shall wherever practicable, elevate structures above the base flood level rather than filling land. In addition, the capped area may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities (e.g., siting) would apply to the site. The SWPD rule (Rule 1200-1-7) and the Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR 257) require that disposal facilities must not be located in a 100-year floodplain, unless both of the following can be demonstrated:

- Location in the floodplain will not restrict the flow of the 100-year flood nor reduce the temporary water storage capacity of the floodplain
- The facility is designed, constructed, operated, and maintained to prevent washout of any solid waste

Wetlands are located to the north and northeast of the facility and landfill, although these locations are not identified on NWI maps. The Protection of Wetlands Order (40 CFR 6) requires that no adverse impacts to wetlands result from a remedial action. With appropriate stormwater runon and runoff controls, the substantive requirements of this ARAR are expected to be met. The SWPD rule requires that new landfills and lateral expansions shall not be located in a wetlands, unless the owner or operator can make the following demonstrations:

- the presumption of a practicable alternative that does not involve wetlands is clearly rebutted,
- the construction/operation of the landfill will not cause or contribute to violations of applicable State water quality standards, any applicable toxic effluent standard or prohibition under Section 307 of the CWA, and will not cause or contribute to the taking of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of endangered or threatened species,
- the landfill will not cause or contribute to significant degradation of wetlands,

- to the extent required under Section 404 of the CWA or Tennessee Water Pollution Control Act, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function), and

- sufficient information is available to make a reasonable determination with respect to these demonstrations.

The substantive requirements for stormwater discharges during construction activities as outlined by the CWA are relevant and appropriate. However, a specific NPDES permit is not required for this remedial action.

All action-specific ARARs are expected to be met. The TAPCR dust suppression and control requirements (Rule 1200-3-8) apply to earth-moving activities associated with this alternative. ARARs for the control of fugitive dust emissions would be met by applying water to roads receiving heavy vehicular traffic and to excavation areas, as necessary.

Long-Term Effectiveness and Permanence

Under this alternative, the cap would have to be maintained to ensure that it continues to perform as designed; consequently, long-term monitoring, inspection, and maintenance would be required. The cap would be susceptible to settlement, ponding of surface water, erosion, and disruption of cover integrity by deep-rooting vegetation and burrowing animals. The cover would to need be periodically inspected, and required maintenance would need to be implemented.

The long-term effectiveness of capping the waste would be enhanced by selecting the proper cover design and grading layout. In addition, access restrictions such as land use controls and fencing would be required to prevent land uses that are incompatible with the site; specifically, land uses that would compromise the cap should be precluded.

Reduction of M/T/V Through Treatment

The primary objective of this alternative is to reduce contaminant mobility by isolating contaminants from receptor contact; contaminant volume or toxicity would not be reduced. Contaminant mobility would be reduced by installing an impermeable cap liner. The liner would eliminate surface water or precipitation infiltration and would greatly reduce contaminant migration to groundwater in conjunction with the existing clay unit beneath the site. Consolidation and capping would isolate waste source areas and reduce contaminant mobility resulting from surface water transport and wind erosion. Contaminant mobility is expected to be reduced to an extent that would result in overall risk reduction from all pathways and exposure routes.

This alternative would not meet EPA's expectation to use treatment to address the principal threats posed by a site, although in some situations, containment of principal threats is warranted (EPA 1991). Based on sample results collected during previous site investigations, 600 CY of surface soil and the 16,000 CY of stockpiled and landfilled slag would be considered "principal-threat" waste.

Containment of principal threats may be warranted where treatment technologies are not technically feasible or available within a reasonable time frame; or where the volume of materials or complexity of the site makes implementation of treatment technologies infeasible; or where implementation of a treatment-based remedy would result in greater overall risk to human health and the environment or cause severe effects across environmental media. A review of currently available technologies and site conditions does not suggest that these situations would apply to the RM site.

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short-term and minimal. Short-term impacts are associated with excavation and consolidation of waste soil and slag; however, these potential, short-term impacts would be mitigated during the construction phase.

If the excavated material is dry, on-site workers will be exposed to waste soil and slag dust during excavation and consolidation activities. Additional exposure to lead dust may occur during building structure and pavement demolition. Ingestion of dust could involve some health effects because of the high level of metals in waste soil and slag.

On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur during waste consolidation and grading. Dust emissions would be monitored at the property boundaries. Fugitive dust emissions would be controlled by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed. A measurable, short-term impact to the surrounding area would include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Implementability

Construction of a geomembrane surface cap is a standard construction practice. Other than capping contaminated material in a floodplain, no significant construction issues are expected to be encountered.

No state or federal permits are expected to be required; however, advance consultation should occur while planning the action to ensure that all involved agencies are allowed to provide input.

All services and materials for this alternative are readily available.

Cost

The total present worth for Alternative 3 is approximately $1,453,803 for Option 1, which includes the excavated wetlands sediment, and $1,430,411 for Option 2, which does not include the wetland sediment. For Option 1, the estimated capital cost is approximately $1,293,907, and the estimated O&M cost is approximately $159,895. For Option 2, the estimated capital cost is approximately $1,270,515, and the estimated O&M cost is approximately $159,895. Detailed cost estimates are in Appendix O.

11.1.1.4 Alternative 4 -- Capping With Construction Of Above-Ground Disposal Cell

Overall Protection of Human Health and the Environment

Successful implementation of this alternative would reduce risks to human health and the environment and meet the removal action objectives by (1) eliminating exposure of residents and trespassers to waste material by direct contact and airborne migration, (2) eliminating exposure of trespassers to direct contact with on-site physical hazards, and (3) further reduce the migration of contaminants to groundwater over Alternative 2 and eliminate the migration of contaminants to surface water. Consolidation and isolation of the waste material beneath a geomembrane cap would eliminate receptor routes of exposure through ingestion and inhalation. Structures throughout the site would be demolished and disposed of in the disposal area above the existing pavement and landfill area. The waste material would be spread and compacted over the landfill area. Physical hazards associated with deteriorating structures would be eliminated. In addition, geomembrane capping would eliminate infiltration of precipitation and surface water that contributes to the migration of contaminants to groundwater. However, because the waste material will remain on site, contaminant migration to groundwater cannot be discounted as an adverse effect. Nevertheless, the elimination of surface water infiltration makes this scenario unlikely, and contaminant migration through surface water runoff to the adjacent wetlands and the Wolf River would be eliminated.

The threat of direct human exposure to contaminated waste and physical hazards would be practically eliminated by this alternative; however, the threat could return over the long term if cap integrity was compromised. The potential for ingestion, dermal contact, and inhalation of soil containing metals would be eliminated by successfully placing the geomembrane cap over the waste material.

Compliance with ARARs

The RCRA hazardous waste disposal facility requirements are potentially applicable. The RM site is located in a 100-year floodplain within a zone designated as A3, indicating that base flood elevations and flood hazard factors have been determined for this area. The ARAR (40 CFR 264) requires that disposal facilities be designed to withstand a 100-year flood. In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains.   In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. Specifically, when it is apparent that a proposed or potential Agency action is likely to impact a floodplain or wetlands, the public should be informed through appropriate public notice processes. Furthermore, if a proposed action is located in or affects a floodplain or wetlands, a floodplain/wetlands assessment shall be undertaken, and a statement of findings explaining why the proposed action must be located in or affect the floodplain or wetlands.

Regarding construction activities related to implementing the alternative, 40 CFR 6 Appendix A requires that EPA-controlled structures and facilities must be constructed in accordance with

existing criteria and standards set forth under the NFIP and must include mitigation of adverse impacts wherever feasible, including the use of accepted floodproofing and/or other flood protection measures. To achieve flood protection, EPA shall wherever practicable, elevate structures above the base flood level rather than filling land. In addition, the capped area may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities (e.g., siting) would apply to the site. The SWPD rule (Rule 1200-1-7) and the Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR 257) require that disposal facilities must not be located in a 100-year floodplain, unless both of the following can be demonstrated:

- Location in the floodplain will not restrict the flow of the 100-year flood nor reduce the temporary water storage capacity of the floodplain

- The facility is designed, constructed, operated, and maintained to prevent washout of any solid waste

Wetlands are located to the north and northeast of the facility and landfill, although these locations are not identified on NWI maps. The Protection of Wetlands Order (40 CFR 6) requires that no adverse impacts to wetlands result from a remedial action. With appropriate stormwater runon and runoff controls, the substantive requirements of this ARAR are expected to be met. The SWPD rule requires that new landfills and lateral expansions shall not be located in a wetlands, unless the owner or operator can make the following demonstrations:

- the presumption of a practicable alternative that does not involve wetlands is clearly rebutted,

- the construction/operation of the landfill will not cause or contribute to violations of applicable State water quality standards, any applicable toxic effluent standard or prohibition under Section 307 of the CWA, and will not cause or contribute to the taking of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of endangered or threatened species,

- the landfill will not cause or contribute to significant degradation of wetlands,

- to the extent required under Section 404 of the CWA or Tennessee Water Pollution Control Act, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function), and

- sufficient information is available to make a reasonable determination with respect to these demonstrations.

The substantive requirements for stormwater discharges during construction activities as outlined by the CWA are relevant and appropriate. However, a specific NPDES permit is not required for this remedial action.

All action-specific ARARs are expected to be met. The TAPCR dust suppression and control requirements (Rule 1200-3-8) apply to earth-moving activities associated with this alternative. ARARs for the control of fugitive dust emissions would be met by applying water to roads receiving heavy vehicular traffic and to excavation areas, as necessary.

Long-Term Effectiveness and Permanence

Under this alternative, the cap would have to be maintained to ensure that it continues to perform as designed; consequently, long-term monitoring, inspection, and maintenance would be required. The cap would be susceptible to settlement, ponding of surface water, erosion, and disruption of cover integrity by deep-rooting vegetation and burrowing animals. The cover would need to be periodically inspected, and required maintenance would need to be implemented.

The long-term effectiveness of capping the waste would be enhanced by selecting the proper cover design and grading layout. In addition, access restrictions such as land use controls and fencing would be required to prevent land uses that are incompatible with the site; specifically, land uses that would compromise the cap should be precluded.

Reduction of M/T/V Through Treatment

The primary objective of this alternative is to reduce contaminant mobility by isolating contaminants from receptor contact; contaminant volume or toxicity would not be reduced. Contaminant mobility would be reduced by installing an impermeable cap liner. The liner would eliminate surface water or precipitation infiltration and would greatly reduce contaminant migration to groundwater in conjunction with the existing clay unit beneath the site. Consolidation and capping would isolate waste source areas and reduce contaminant mobility resulting from surface water transport and wind erosion. Contaminant mobility is expected to be reduced to an extent that would result in overall risk reduction from all pathways and exposure routes.

Based on sample results collected during previous site investigations, 600 CY of surface soil and the 16,000 CY of stockpiled and landfilled slag would be considered "principal-threat" waste. This alternative would not meet EPA's expectation to use treatment to address the principal threats posed by a site, although in some situations, containment of principal threats is warranted (EPA 1991).

Containment of principal threats may be warranted where treatment technologies are not technically feasible or available within a reasonable time frame; or where the volume of materials or complexity of the site makes implementation of treatment technologies infeasible; or where implementation of a treatment-based remedy would result in greater overall risk to human health and the environment or cause severe effects across environmental media. A review of currently available technologies and site conditions does not suggest that these situations would apply to the RM site.

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short-term and minimal. Short-term impacts are associated with excavation and consolidation of waste soil and slag; however, these potential, short-term impacts would be mitigated during the construction phase.

If the excavated material is dry, on-site workers will be exposed to waste soil and slag dust during excavation and consolidation activities. Additional exposure to lead dust may occur during building structure and pavement demolition. Ingestion of dust could involve some health effects because of the high level of metals in waste soil and slag.

On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur during waste consolidation and grading. Dust emissions would be monitored at the property boundaries. Fugitive dust emissions would be controlled by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed. A measurable, short-term impact to the surrounding area would include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Implementability

Construction of a geomembrane surface cap is a standard construction practice. Other than capping contaminated material in a floodplain, no significant construction issues are expected to be encountered.

No state or federal permits are expected to be required; however, advance consultation should occur while planning the action to ensure that all involved agencies are allowed to provide input.

All services and materials for this alternative are readily available.

Cost

The total present worth for Alternative 4 is approximately $1,506,847 for Option 1, which includes the excavated wetlands sediment, and $1,481,865 for Option 2, which does not include the wetland sediment. For Option 1, the estimated capital cost is approximately $1,346,951, and the estimated O&M cost is approximately $159,895. For Option 2, the estimated capital cost is approximately $1,321,970, and the estimated O&M cost is approximately $159,895. Detailed cost estimates are in Appendix O.

11.1.1.5 Alternative 5 -- Excavation and Onsite Treatment With Solidification/Stabilization

11.1.1.5.1 Option A - Onsite Disposal

Overall Protection of Human Health and the Environment

Successful implementation of this alternative would eliminate risks to human health and the environment and meet the removal action objectives by (1) eliminating exposure of residents and trespassers to waste material by direct contact and airborne migration, (2) eliminating exposure of trespassers to direct contact with on-site physical hazards, and (3) eliminating the migration of contaminants to groundwater and surface water. The threat of direct human exposure to contaminated waste and physical hazards would be eliminated by this alternative. Treatment of the waste material would eliminate contaminant exposure through the receptor routes of ingestion and inhalation. Contaminated soil and slag would be treated and converted to a nonhazardous material. Structures throughout the site would be demolished and either disposed of in an excavated disposal area beneath the existing pavement or recycled. As a result, physical hazards associated with deteriorating structures would be eliminated. Waste immobilized by treatment or removed by decontamination would eliminate contaminant migration from the site.

Compliance with ARARs

The State of Tennessee SWPD rules are potentially applicable. The State may classify the on-site disposal area for treated waste as a Class II (industrial waste) landfill facility. Class II facilities must meet the same requirements as Class I (solid waste) disposal facilities unless a waiver of one or more of the standards is obtained as set forth in SWPD Rule 1200-1-7-.01(5). Class I standards include requirements for landfill liners, geologic buffers, leachate collection systems, and other requirements that may not be necessary for the RM site to be protective of human health and the environment. The SWPD rule also includes buffer zone standards for Class II facilities. These standards require that new facilities be located so that fill areas are, at a minimum, 100 feet from all property lines and 500 feet from all residences unless the owner agrees in writing to a shorter distance. A disposal area that is constructed to be about 700 feet by 250 feet would likely meet both the buffer zone and capacity requirements for the RM site.

The RM site is located in a 100-year floodplain within a zone designated as A3, indicating that base flood elevations and flood hazard factors have been determined for this area. The SWPD rule (Rule 1200-1-7) and the Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR 257) require that disposal facilities must not be located in a 100-year floodplain, unless both of the following can be demonstrated:

- Location in the floodplain will not restrict the flow of the 100-year flood nor reduce the temporary water storage capacity of the floodplain
- The facility is designed, constructed, operated, and maintained to prevent washout of any solid waste

In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains.

Specifically, when it is apparent that a proposed or potential Agency action is likely to impact a floodplain or wetlands, the public should be informed through appropriate public notice processes. Furthermore, if a proposed action is located in or affects a floodplain or wetlands, a floodplain/wetlands assessment shall be undertaken, and a statement of findings explaining why the proposed action must be located in or affect the floodplain or wetlands.

Regarding construction activities related to implementing the alternative, 40 CFR 6 Appendix A requires that EPA-controlled structures and facilities must be constructed in accordance with existing criteria and standards set forth under the NFIP and must include mitigation of adverse impacts wherever feasible, including the use of accepted floodproofing and/or other flood protection measures. To achieve flood protection, EPA shall wherever practicable, elevate structures above the base flood level rather than filling land.

Wetlands are located to the north and northeast of the facility and landfill, although these locations are not identified on NWI maps. The SWPD rule requires that new landfills and lateral expansions shall not be located in a wetlands, unless the owner or operator can make the following demonstrations:

- the presumption of a practicable alternative that does not involve wetlands is clearly rebutted,
- the construction/operation of the landfill will not cause or contribute to violations of applicable State water quality standards, any applicable toxic effluent standard or prohibition under Section 307 of the CWA, and will not cause or contribute to the taking of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of endangered or threatened species,
- the landfill will not cause or contribute to significant degradation of wetlands,
- to the extent required under Section 404 of the CWA or Tennessee Water Pollution Control Act, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function), and

- sufficient information is available to make a reasonable determination with respect to these demonstrations.

The Protection of Wetlands Order (40 CFR 6) also requires that no adverse impacts to wetlands result from a remedial action. Historical evidence suggests that the existing landfill was created in a wetland. However, this area was not observed to contain standing water during sampling events conducted in 1996 and 1997. It is not known whether the area of the existing landfill would be classified as a wetland area.

The substantive requirements for stormwater discharges during construction activities as outlined by the CWA are relevant and appropriate. However, a specific NPDES permit is not required for this removal action.

All action-specific ARARs are expected to be met. The Tennessee Air Pollution Air Control Regulations (TAPCR) dust suppression and control requirements (Rule 1200-3-8) apply to earth-moving activities associated with this alternative. If remedial equipment is used on site such as a pugmill mixer or crusher, dust and vapors generated from the use of this equipment will be contained and treated before being discharged to the atmosphere, if required. ARARs for the control of fugitive dust emissions would be met by applying water to roads receiving heavy vehicular traffic and to excavation areas, as necessary.

Long-Term Effectiveness and Permanence

If the disposal area is classified as a Class II disposal facility, the area may have to be maintained to ensure that it continues to perform as designed; consequently, monitoring, inspection, and maintenance would be required. The soil cover area would be susceptible to settlement, ponding of surface water, erosion, and disruption of cover integrity by deep-rooting vegetation and burrowing animals. However, the cover would be periodically inspected, and required maintenance could be implemented.

If the RM site is not classified as a Class II disposal facility; monitoring, inspection, and maintenance may not be required. Treatment reagents are typically tested by the Multiple Extraction Procedure (MEP, SW-846 Method 1320) to measure long-term stability. The test is intended to approximate leachability under acidic conditions over a 1,000-year time frame. Based on successful completion of bench-scale testing that would include MEP analysis, this alternative is expected to provide adequate long-term effectiveness and permanence. Access restrictions such as land use controls and fencing may be required to prevent land uses incompatible with the site.

Reduction of M/T/V Through Treatment

The primary objective of this alternative is to reduce contaminant toxicity and mobility through treatment; contaminant volume would not be reduced. Contaminant toxicity would be reduced by altering the physical or chemical structure of the contaminant into a nonhazardous material. Contaminant mobility would be reduced by binding or bonding the contaminant into a nonleachable form that would eliminate contaminant migration from the site. Contaminant mobility is expected to be reduced to an extent that would result in overall risk reduction from all pathways and exposure routes.

Based on sample results collected during previous site investigations, 600 CY of surface soil and the 16,000 CY of stockpiled and landfilled slag would be considered "principal-threat" waste. This alternative meets EPA's expectation to use treatment to address the principal threats posed by a site by treating all the contaminated soil, sediment, and slag. However, treatment of what would be considered low-level threat waste does not meet EPA's expectation to use containment to address such waste, although in some situations, treatment rather than containment of low-level threats is warranted (EPA 1991).

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short term and minimal. Short-term impacts are associated with excavation, consolidation, and treatment of waste soil and slag; however, these potential, short-term impacts would be mitigated during the construction phase.

If the excavated material is dry, on-site workers will be exposed to waste soil and slag dust during excavation and consolidation activities. Additional exposure to lead dust may occur during the decontamination and demolition of building structures and pavement. Ingestion of dust could involve some health effects because of the high level of metals in waste soil and slag.

On-site workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur during waste consolidation and grading. Dust emissions would be monitored at the property boundaries. Fugitive dust emissions would be controlled by applying water as needed to surfaces receiving heavy vehicular traffic or in excavation areas. A measurable, short-term impact to the surrounding area would include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Implementability

Treatment of contaminated soil and slag is offered by numerous vendors. On-site treatment utilizes standard construction practices and material handling equipment. No significant construction issues are expected to be encountered.

Treatment of the contaminated waste will likely increase the volume of the waste soil and slag material; however, slight volume reductions may occur when some chemical reagents are used to treat the material. Typical volume increases range from about 5 percent to as high as 100 percent, depending upon the treatment method used. An increase in the volume of the treated waste material will have an impact on the disposal volume required. Calculations used in the development of this alternative utilized a volume increase estimate of 20 percent.

The dimensions of the site property are about 450 by 800 feet, including the existing landfill. The waste storage capacity required for this alternative is 49,150 CY assuming a 20 percent volume increase of the treated material. To meet the SWDP buffer zone siting standards, the excavation area would be 700 by 250 feet, and with an 8-ft average depth, depending on the thickness of the clay unit. The disposal area would be located beneath the existing pavement.

Wastewater may be generated during implementation of this alternative through water runoff generated as a result of dust emission control. Wastewater may also be generated as a result of decontamination activities required for equipment and on-site workers. Containment and treatment or disposal of these wastewaters may be required. Depending upon the treatment methodology selected, the wastewater may be able to be utilized in the soils treatment process.

The on-site disposal area for the treated waste may be classified as a Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities would apply to the site.

All services and materials for this alternative are readily available.

Cost

The total present worth for Alternative 5A is approximately $4,907,274 for Option 1, which includes the excavated wetlands sediment, and $4,244,992 for Option 2, which does not include the wetland sediment. For Option 1, the estimated capital cost is approximately $4,743,474, and the estimated O&M cost is approximately $163,799. For Option 2, the estimated capital cost is approximately $4,081,193, and the estimated O&M cost is approximately $163,799. Detailed cost estimates are in Appendix O.

11.1.1.5.1 Option B - Offsite Disposal

Overall Protection of Human Health and the Environment

Successful implementation of this alternative would eliminate risks to human health and the environment and meet the removal action objectives by (1) eliminating exposure of residents and trespassers to waste material by direct contact and airborne migration, (2) eliminating exposure of trespassers to direct contact with on-site physical hazards, and (3) eliminating the migration of contaminants to groundwater and surface water. The threat of direct human exposure to contaminated waste and physical hazards would be eliminated by this alternative. Treatment and removal of the waste material would eliminate contaminant exposure through the receptor routes of ingestion and inhalation. Contaminated soil and slag would be treated and converted to a nonhazardous material and transported to an off-site disposal facility. Structures throughout the site would be demolished and either disposed of in an excavated disposal area beneath the existing pavement or recycled. As a result, physical hazards associated with deteriorating structures would be eliminated. Removal of waste would mitigate contaminant migration from the site.

Compliance with ARARs

All action-specific ARARs are expected to be met. The TAPCR dust suppression and control requirements (Rule 1200-3-8) apply to earth-moving activities associated with this alternative. If remedial equipment is used on site, such as a pugmill mixer or crusher, dust and vapors generated from the use of this equipment will be contained and treated before being discharged to the atmosphere, if required. ARARs for the control of fugitive dust emissions would be met by applying water to roads receiving heavy vehicular traffic and to excavation areas, as necessary.

Long-Term Effectiveness and Permanence

Treatment and removal of the waste material would not require monitoring, inspection, or maintenance for the site. Treatment reagents are typically tested by MEP SW-846 Method 1320 to measure long-term stability. The test is intended to approximate leachability under acidic conditions over a 1,000-year time frame. Based on successful completion of bench-scale testing that would include MEP analysis, this alternative is expected to provide adequate long-term effectiveness and permanence. Access restrictions such as land use controls and fencing would likely not be required.

Reduction of M/T/V Through Treatment

The primary objective of this alternative is to reduce contaminant toxicity and mobility through treatment; contaminant volume would not be physically reduced. Contaminant toxicity would be reduced by altering the physical or chemical structure of the contaminant into a nonhazardous material. Contaminant mobility would be reduced by binding or bonding the contaminant into a nonleachable form. Subsequent removal would mitigate contaminant migration from the site. Contaminant volume would not be physically reduced under this alternative.

Based on sample results collected during previous site investigations, 600 CY of surface soil and the 16,000 CY of stockpiled and landfilled slag would be considered "principal-threat" waste. This alternative meets EPA's expectation to use treatment to address the principal threats posed by a site by treating all the contaminated soil, sediment, and slag. However, treatment of what would be considered low-level threat waste does not meet EPA's expectation to use containment to address such waste, although in some situations, treatment rather than containment of low-level threats is warranted (EPA 1991).

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short term and minimal. Short-term impacts are associated with excavation, consolidation and treatment of waste soil and slag; however, these potential, short-term impacts would be mitigated during the construction phase.

If the excavated material is dry, on-site workers will be exposed to waste soil and slag dust during excavation and consolidation activities. Additional exposure to lead dust may occur during the decontamination and demolition of building structures and pavement. Ingestion of dust could involve some health effects because of the high level of metals in waste soil and slag.

On-site workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur during waste consolidation and grading. Monitoring of dust emissions would be monitored at the property boundaries. Fugitive dust emissions would be controlled by applying water as needed to surfaces receiving heavy vehicular traffic or in excavation areas. A measurable, short-term impact to the surrounding area would include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Implementability

Treatment of contaminated soil and slag is offered by numerous vendors. On-site treatment utilizes standard construction practices and material handling equipment. No significant construction issues are expected to be encountered.

Treatment of the contaminated waste will likely increase the volume of waste soil and slag material; however, a slight volume reduction may occur if a chemical reagent is used to treat the material. Typical volume increases range from about 5 percent to as high as 100 percent, depending upon the treatment methodology used. An increase in the volume of the treated waste material will have an impact on the transportation costs to a disposal facility. Calculations used in the development of this alternative assume a volume increase of 20 percent.

Wastewater may be generated during implementation of this alternative through water runoff generated as a result of dust emission control. Wastewater may also be generated as a result of decontamination activities required for both equipment and on-site workers. Containment and treatment or disposal of these wastewaters may be required. Depending upon the treatment methodology selected, the wastewater may be able to be utilized in the soils treatment process.

No state or federal permits are expected to be required; however, advance consultation should occur in planning the action to ensure that all involved agencies are allowed to provide input.

All services and materials for this alternative are readily available.

Cost

The total present worth for Alternative 5B is approximately $7,477,199 for Option 1, which includes the excavated wetlands sediment, and $6,181,160 for Option 2, which does not include the wetland sediment. For Option 1, the estimated capital cost is approximately $7,313,400, and the estimated O&M cost is approximately $163,799. For Option 2, the estimated capital cost is approximately $6,017,361, and the estimated O&M cost is approximately $163,799. Detailed cost estimates are in Appendix O.

11.1.1.6 Alternative 6 -- Capping With Excavation and Onsite Treatment of Principal-Threat Waste

11.1.1.6.1 Option A - Onsite Disposal of Treated Principal-Threat Waste

Overall Protection of Human Health and the Environment

Successful implementation of this alternative would reduce risks to human health and the environment and meet the removal action objectives by (1) eliminating exposure of residents and trespassers to waste material by direct contact and airborne migration, (2) eliminating exposure of trespassers to direct contact with on-site physical hazards, and (3) further reduce the migration of contaminants to groundwater over Alternative 2 and eliminate the migration of contaminants to surface water. Consolidation and isolation of the waste material beneath a geomembrane cap would eliminate receptor routes of exposure through ingestion and inhalation. Structures throughout the site would be demolished and disposed of in the disposal area above the existing pavement and landfill area. The waste material would be spread and compacted throughout the site. Physical hazards associated with deteriorating structures would be eliminated. In addition, geomembrane capping would eliminate infiltration of precipitation and surface water that contributes to the migration of contaminants to groundwater. However, because the waste material will remain on site, contaminant migration to groundwater cannot be discounted as an adverse effect. Nevertheless, the elimination of surface water infiltration makes this scenario unlikely, and contaminant migration through surface water runoff to the adjacent wetlands and the Wolf River would be eliminated.

The threat of direct human exposure to contaminated waste and physical hazards would be practically eliminated by this alternative; however, the threat could return over the long term if cap integrity was compromised. The potential for ingestion, dermal contact, and inhalation of soil containing metals would be eliminated by successfully placing the geomembrane cap over the waste material.

Compliance with ARARs

The RCRA hazardous waste disposal facility requirements are potentially applicable. The RM site is located in a 100-year floodplain within a zone designated as A3, indicating that base flood elevations and flood hazard factors have been determined for this area. The ARAR (40 CFR 264) requires that disposal facilities be designed to withstand a 100-year flood. In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. Specifically, when it is apparent that a proposed or potential Agency action is likely to impact a floodplain or wetlands, the public should be informed through appropriate public notice processes. Furthermore, if a proposed action is located in or affects a floodplain or wetlands, a floodplain/wetlands assessment shall be undertaken, and a statement of findings explaining why the proposed action must be located in or affect the floodplain or wetlands.

Regarding construction activities related to implementing the alternative, 40 CFR 6 Appendix A requires that EPA-controlled structures and facilities must be constructed in accordance with existing criteria and standards set forth under the NFIP and must include mitigation of adverse impacts wherever feasible, including the use of accepted floodproofing and/or other flood protection measures. To achieve flood protection, EPA shall wherever practicable, elevate structures above the base flood level rather than filling land. In addition, the capped area may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities (e.g., siting) would apply to the site. The SWPD rule (Rule 1200-1-7) and the Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR 257) require that disposal facilities must not be located in a 100-year floodplain, unless both of the following can be demonstrated:

- Location in the floodplain will not restrict the flow of the 100-year flood nor reduce the temporary water storage capacity of the floodplain

- The facility is designed, constructed, operated, and maintained to prevent washout of any solid waste

Wetlands are located to the north and northeast of the facility and landfill, although these locations are not identified on NWI maps. The Protection of Wetlands Order (40 CFR 6) requires that no adverse impacts to wetlands result from a remedial action. With appropriate stormwater runon and runoff controls, the substantive requirements of this ARAR are expected to be met. The SWPD rule requires that new landfills and lateral expansions shall not be located in a wetlands, unless the owner or operator can make the following demonstrations:

- the presumption of a practicable alternative that does not involve wetlands is clearly rebutted,
- the construction/operation of the landfill will not cause or contribute to violations of applicable State water quality standards, any applicable toxic effluent standard or prohibition under Section 307 of the CWA, and will not cause or contribute to the taking of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of endangered or threatened species,
- the landfill will not cause or contribute to significant degradation of wetlands,
- to the extent required under Section 404 of the CWA or Tennessee Water Pollution Control Act, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function), and
- sufficient information is available to make a reasonable determination with respect to these demonstrations.

The substantive requirements for stormwater discharges during construction activities as outlined by the CWA are relevant and appropriate. However, a specific NPDES permit is not required for this remedial action.

All action-specific ARARs are expected to be met. The TAPCR dust suppression and control requirements (Rule 1200-3-8) apply to earth-moving activities associated with this alternative. ARARs for the control of fugitive dust emissions would be met by applying water to roads receiving heavy vehicular traffic and to excavation areas, as necessary.

Long-Term Effectiveness and Permanence

Under this alternative, the cap would have to be maintained to ensure that it continues to perform as designed; consequently, long-term monitoring, inspection, and maintenance would be required. The cap would be susceptible to settlement, ponding of surface water, erosion, and disruption of cover integrity by deep-rooting vegetation and burrowing animals. However, the cover would be periodically inspected, and required maintenance could be implemented.

The long-term effectiveness of capping the waste would be enhanced by selecting the proper cover design and grading layout. In addition, access restrictions such as land use controls and fencing would be required to prevent land uses that are incompatible with the site; specifically, land uses that would compromise the cap should be precluded.

Reduction of M/T/V Through Treatment

The primary objective of this alternative is to reduce contaminant mobility by isolating contaminants from receptor contact; contaminant volume or toxicity would not be reduced. Contaminant mobility would be reduced by installing an impermeable cap liner. The liner would eliminate surface water or precipitation infiltration and would greatly reduce contaminant migration to groundwater in conjunction with the existing clay unit beneath the site. Consolidation and capping would isolate waste source areas and reduce contaminant mobility resulting from surface water transport and wind erosion. Contaminant mobility is expected to be reduced to an extent that would result in overall risk reduction from all pathways and exposure routes.

This alternative would meet EPA's expectation to use treatment to address the principal threats posed by a site, as well as EPA's expectation to use containment to address low-level threats posed by a site. Based on sample results collected during previous site investigations, 600 CY of surface soil and the 16,000 CY of stockpiled and landfilled slag would be considered "principal-threat" waste.

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short-term and minimal. Short-term impacts are associated with excavation and consolidation of waste soil and slag; however, these potential, short-term impacts would be mitigated during the construction phase.

If the excavated material is dry, on-site workers will be exposed to waste soil and slag dust during excavation and consolidation activities. Additional exposure to lead dust may occur during building structure and pavement demolition. Ingestion of dust could involve some health effects because of the high level of metals in waste soil and slag.

On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur during waste consolidation and grading. Dust emissions would be monitored at the property boundaries. Fugitive dust emissions would be controlled by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed. A measurable, short-term impact to the surrounding area would include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Implementability

Construction of a geomembrane surface cap is a standard construction practice. Other than capping treated and low level-threat material in a floodplain, no significant construction issues are expected to be encountered.

Treatment of contaminated soil and slag is offered by numerous vendors. On-site treatment utilizes standard construction practices and material handling equipment. No significant construction issues are expected to be encountered.

Treatment of the contaminated waste will likely increase the volume of the waste soil and slag material; however, slight volume reductions may occur when some chemical reagents are used to treat the material. Typical volume increases range from about 5 percent to as high as 100 percent, depending upon the treatment method used. An increase in the volume of the treated waste material will have an impact on the disposal volume required. Calculations used in the development of this alternative utilized a volume increase estimate of 5 percent.

The on-site disposal area for the treated waste may be classified as a Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities would apply to the site.

All services and materials for this alternative are readily available.

Cost

The total present worth for Alternative 6A is approximately $3,175,137 for Option 1, which includes the excavated wetlands sediment, and $2,729,543 for Option 2, which does not include the wetland sediment. For Option 1, the estimated capital cost is approximately $3,015,241, and the estimated O&M cost is approximately $159,895. For Option 2, the estimated capital cost is approximately $2,569,647, and the estimated O&M cost is approximately $159,895. Detailed cost estimates are in Appendix O.

11.1.1.6.2 Option B - Offsite Disposal of Treated Principal-Threat Waste

Overall Protection of Human Health and the Environment

Successful implementation of this alternative would reduce risks to human health and the environment and meet the removal action objectives by (1) eliminating exposure of residents and trespassers to waste material by direct contact and airborne migration, (2) eliminating exposure of trespassers to direct contact with on-site physical hazards, and (3) further reduce the migration of contaminants to groundwater over Alternative 2 and eliminate the migration of contaminants to surface water. Consolidation and isolation of low level-threat waste material beneath a geomembrane cap would eliminate receptor routes of exposure through ingestion and inhalation. Structures throughout the site would be demolished and disposed of in the disposal area above the existing pavement and landfill area. The waste material would be spread and compacted throughout the site. Physical hazards associated with deteriorating structures would be eliminated. In addition, geomembrane capping would eliminate infiltration of precipitation and surface water that contributes to the migration of contaminants to groundwater. However, because the waste material will remain on site, contaminant migration to groundwater cannot be discounted as an adverse effect. Nevertheless, the elimination of surface water infiltration makes this scenario unlikely, and contaminant migration through surface water runoff to the adjacent wetlands and the Wolf River would be eliminated.

The threat of direct human exposure to contaminated waste and physical hazards would be practically eliminated by this alternative; however, the threat could return over the long term if cap integrity was compromised. The potential for ingestion, dermal contact, and inhalation of soil containing metals would be eliminated by successfully placing the geomembrane cap over the waste material.

Compliance with ARARs

The RCRA hazardous waste disposal facility requirements are potentially applicable. The RM site is located in a 100-year floodplain within a zone designated as A3, indicating that base flood elevations and flood hazard factors have been determined for this area. The ARAR (40 CFR 264) requires that disposal facilities be designed to withstand a 100-year flood. In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. Specifically, when it is apparent that a proposed or potential Agency action is likely to impact a floodplain or wetlands, the public should be informed through appropriate public notice processes. Furthermore, if a proposed action is located in or affects a floodplain or wetlands, a floodplain/wetlands assessment shall be undertaken, and a statement of findings explaining why the proposed action must be located in or affect the floodplain or wetlands.

Regarding construction activities related to implementing the alternative, 40 CFR 6 Appendix A requires that EPA-controlled structures and facilities must be constructed in accordance with existing criteria and standards set forth under the NFIP and must include mitigation of adverse impacts wherever feasible, including the use of accepted floodproofing and/or other flood protection measures. To achieve flood protection, EPA shall wherever practicable, elevate structures above the base flood level rather than filling land. In addition, the capped area may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities (e.g., siting) would apply to the site. The SWPD rule (Rule 1200-1-7) and the Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR 257) require that disposal facilities must not be located in a 100-year floodplain, unless both of the following can be demonstrated:

! Location in the floodplain will not restrict the flow of the 100-year flood nor reduce the temporary water storage capacity of the floodplain

! The facility is designed, constructed, operated, and maintained to prevent washout of any solid waste

Wetlands are located to the north and northeast of the facility and landfill, although these locations are not identified on NWI maps. The Protection of Wetlands Order (40 CFR 6) requires that no adverse impacts to wetlands result from a remedial action. With appropriate stormwater runon and runoff controls, the substantive requirements of this ARAR are expected to be met. The SWPD rule requires that new landfills and lateral expansions shall not be located in a wetlands, unless the owner or operator can make the following demonstrations:

- the presumption of a practicable alternative that does not involve wetlands is clearly rebutted,
- the construction/operation of the landfill will not cause or contribute to violations of applicable State water quality standards, any applicable toxic effluent standard or prohibition under Section 307 of the CWA, and will not cause or contribute to the taking of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of endangered or threatened species,
- the landfill will not cause or contribute to significant degradation of wetlands,
- to the extent required under Section 404 of the CWA or Tennessee Water Pollution Control Act, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function), and
- sufficient information is available to make a reasonable determination with respect to these demonstrations.

The substantive requirements for stormwater discharges during construction activities as outlined by the CWA are relevant and appropriate. However, a specific NPDES permit is not required for this remedial action.

All action-specific ARARs are expected to be met. The TAPCR dust suppression and control requirements (Rule 1200-3-8) apply to earth-moving activities associated with this alternative. ARARs for the control of fugitive dust emissions would be met by applying water to roads receiving heavy vehicular traffic and to excavation areas, as necessary.

Long-Term Effectiveness and Permanence

Under this alternative, the cap would have to be maintained to ensure that it continues to perform as designed; consequently, long-term monitoring, inspection, and maintenance would be required. The cap would be susceptible to settlement, ponding of surface water, erosion, and disruption of cover integrity by deep-rooting vegetation and burrowing animals. However, the cover would be periodically inspected, and required maintenance could be implemented.

The long-term effectiveness of capping the waste would be enhanced by selecting the proper cover design and grading layout. In addition, access restrictions such as land use controls and fencing would be required to prevent land uses that are incompatible with the site; specifically, land uses that would compromise the cap should be precluded.

Reduction of M/T/V Through Treatment

The primary objective of this alternative is to reduce contaminant mobility by isolating contaminants from receptor contact; contaminant volume or toxicity would not be reduced. Contaminant mobility would be reduced by installing an impermeable cap liner. The liner would eliminate surface water or precipitation infiltration and would greatly reduce contaminant migration to groundwater in conjunction with the existing clay unit beneath the site. Consolidation and capping would isolate waste source areas and reduce contaminant mobility resulting from surface water transport and wind erosion. Contaminant mobility is expected to be reduced to an extent that would result in overall risk reduction from all pathways and exposure routes.

This alternative would meet EPA's expectation to use treatment to address the principal threats posed by a site, as well as EPA's expectation to use containment to address low-level threats posed by a site. Based on sample results collected during previous site investigations, 600 CY of surface soil and the 16,000 CY of stockpiled and landfilled slag would be considered "principal-threat" waste.

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short-term and minimal. Short-term impacts are associated with excavation and consolidation of waste soil and slag; however, these potential, short-term impacts would be mitigated during the construction phase.

If the excavated material is dry, on-site workers will be exposed to waste soil and slag dust during excavation and consolidation activities. Additional exposure to lead dust may occur during building structure and pavement demolition. Ingestion of dust could involve some health effects because of the high level of metals in waste soil and slag.

On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur during waste consolidation and grading. Dust emissions would be monitored at the property boundaries. Fugitive dust emissions would be controlled by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed. A measurable, short-term impact to the surrounding area would include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Implementability

Construction of a geomembrane surface cap is a standard construction practice. Other than capping low level-threat material in a floodplain, no significant construction issues are expected to be encountered.

Treatment of contaminated soil and slag is offered by numerous vendors. On-site treatment utilizes standard construction practices and material handling equipment. No significant construction issues are expected to be encountered.

Treatment of the contaminated waste will likely increase the volume of the waste soil and slag material; however, slight volume reductions may occur when some chemical reagents are used to treat the material. Typical volume increases range from about 5 percent to as high as 100 percent, depending upon the treatment method used. An increase in the volume of the treated waste material will have an impact on the disposal volume required. Calculations used in the development of this alternative utilized a volume increase estimate of 5 percent.

All services and materials for this alternative are readily available.

Cost

The total present worth for Alternative 6B is approximately $4,936,044 for Option 1, which includes the excavated wetlands sediment, and $4,013,508 for Option 2, which does not include the wetland sediment. For Option 1, the estimated capital cost is approximately $4,776,149, and the estimated O&M cost is approximately $159,895. For Option 2, the estimated capital cost is approximately $3,853,613 and the estimated O&M cost is approximately $159,895. Detailed cost estimates are in Appendix O.

11.1.2 ANALYSIS OF WETLAND SEDIMENT ALTERNATIVES

11.1.2.1 <u>Alternative 1 -- No Action</u>

Overall Protection of Human Health and the Environment

The no action alternative does not eliminate any exposure pathways or reduce the level of risk of the existing wetland sediment contamination.

Compliance with ARARs

This alternative does not achieve the RAOs or chemical-specific ARARs established for wetland sediment. Location- and action-specific ARARs do not apply to this alternative since further remedial actions will not be conducted.

Long-Term Effectiveness and Permanence

The remediation goals derived for protection of ecological receptors would not be met. Because contaminated wetland sediment remains under this alternative, a review/reassessment of the conditions at the site would be performed at 5-year intervals to ensure that the remedy does not become a greater risk to human health and the environment.

Reduction of M/T/V Through Treatment

No reductions in contaminants M/T/V are realized under this alternative.

Short-Term Effectiveness

Since no further remedial action would be implemented at this site, this alternative poses no short-term risks to onsite workers. It is assumed that Level D personnel protection would be used when sampling various media.

Implementability

This alternative could be implemented immediately since monitoring equipment is readily available and procedures are in place.

11.1.2.2 Alternative 2 -- Capping With Clean Fill and Off-site Creation of Wetlands

Overall Protection of Human Health and the Environment

This alternative will not remove or contain the contaminated sediments but potentially limits multiple exposure pathways to ecological receptors. Organisms utilizing portions of the wetlands below the surface may potentially continue to be exposed. The volume and concentration in the wetland will not be altered. Lead and other metals in the wetland sediment may continue to result in adverse impacts. of contaminants to surface water.

Compliance with ARARs

The RCRA hazardous waste disposal facility requirements are potentially applicable. The RM site is located in a 100-year floodplain within a zone designated as A3, indicating that base flood elevations and flood hazard factors have been determined for this area. The ARAR (40 CFR 264) requires that disposal facilities be designed to withstand a 100-year flood. In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. Specifically, when it is apparent that a proposed or potential Agency action is likely to impact a floodplain or wetlands, the public should be informed through appropriate public notice processes. Furthermore, if a proposed action is located in or affects a floodplain or wetlands, a floodplain/wetlands assessment shall be undertaken, and a statement of findings explaining why the proposed action must be located in or affect the floodplain or wetlands.

Regarding construction activities related to implementing the alternative, 40 CFR 6 Appendix A requires that EPA-controlled structures and facilities must be constructed in accordance with existing criteria and standards set forth under the NFIP and must include mitigation of adverse impacts wherever feasible, including the use of accepted floodproofing and/or other flood protection measures. To achieve flood protection, EPA shall wherever practicable, elevate structures above the base flood level rather than filling land. In addition, the capped area may be classified as a Tennessee SWPD Class II disposal facility. If so, the substantive requirements of the SWPD rule regarding Class II disposal facilities (e.g., siting) would apply to the site. The SWPD rule (Rule 1200-1-7) and the Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR 257) require that disposal facilities must not be located in a 100-year floodplain, unless both of the following can be demonstrated:

- Location in the floodplain will not restrict the flow of the 100-year flood nor reduce the temporary water storage capacity of the floodplain
- The facility is designed, constructed, operated, and maintained to prevent washout of any solid waste

The Protection of Wetlands Order (40 CFR 6) requires that no adverse impacts to wetlands result from a remedial action. With appropriate stormwater runon and runoff controls, the substantive requirements of this ARAR are expected to be met. In addition, the off-site creation of wetlands component of this alternative to compensate for the loss of forested and scrub/shrub wetlands is expected to meet the wetlands mitigation requirements of CWA Section 404. The SWPD rule requires that new landfills and lateral expansions shall not be located in a wetlands, unless the owner or operator can make the following demonstrations:

- the presumption of a practicable alternative that does not involve wetlands is clearly rebutted,
- the construction/operation of the landfill will not cause or contribute to violations of applicable State water quality standards, any applicable toxic effluent standard or prohibition under Section 307 of the CWA, and will not cause or contribute to the taking

of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of endangered or threatened species,

- the landfill will not cause or contribute to significant degradation of wetlands,
- to the extent required under Section 404 of the CWA or Tennessee Water Pollution Control Act, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function), and
- sufficient information is available to make a reasonable determination with respect to these demonstrations.

The substantive requirements for stormwater discharges during construction activities as outlined by the CWA are relevant and appropriate. However, a specific NPDES permit is not required for this remedial action.

All action-specific ARARs are expected to be met. The TAPCR dust suppression and control requirements (Rule 1200-3-8) apply to earth-moving activities associated with this alternative. ARARs for the control of fugitive dust emissions would be met by applying water to roads receiving heavy vehicular traffic and to excavation areas, as necessary.

Long-Term Effectiveness and Permanence

Under this alternative, the cap would have to be maintained to ensure that it continues to perform as designed; consequently, long-term monitoring, inspection, and maintenance would be required. The cap would be susceptible to settlement, ponding of surface water, erosion, and disruption of cover integrity by deep-rooting vegetation and burrowing animals. The cover would need to be periodically inspected, and required maintenance would need to be implemented in order to maintain effectiveness.

The long-term effectiveness of capping the waste would be enhanced by selecting the proper cover design and grading layout. In addition, access restrictions such as land use controls and fencing would be required to prevent land uses incompatible with the site; specifically, land uses that would compromise the cap should be precluded.

The remedial action objectives of reduction of exposure and prevention of transport and migration of site contaminants, and prevention of degradation of adjacent wetlands will be achieved. However, the restoration of wetland communities and elimination of further degradation of the site wetlands will not be achieved.

Reduction of M/T/V Through Treatment

This alternative will not remove or dispose of the contamination. Contaminated sediment will be left intact but the pathway of exposure will be reduced for multiple receptors. Toxicity may be reduced by limiting bioavailability. The volume of material at the site will not be altered.

This alternative would not meet EPA's expectation to use treatment to address the principal threats posed by a site, although in some situations, containment of principal threats is warranted (EPA 1991). Based on sample results collected during previous site investigations, 8,700 CY of sediment would be considered "principal-threat" waste.

Containment of principal threats may be warranted where treatment technologies are not technically feasible or available within a reasonable time frame; or where the volume of materials or complexity of the site makes implementation of treatment technologies infeasible; or where implementation of a treatment-based remedy would result in greater overall risk to human health and the environment or cause severe effects across environmental media. A review of currently available technologies and site conditions does not suggest that these situations would apply to the RM site.

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short term and minimal.

On-site workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures.

The wetland system would be destroyed since application of the cap will alter grade and hydrology. A measurable, short-term impact to the surrounding area would include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Implementability

Construction of a soil cap is a standard construction practice and materials are readily available. Other than the capping of contaminated material in a floodplain and wetland, no significant construction issues are expected to be encountered.

ACOE permits are expected to be required. Advance consultation should occur while planning the action to ensure that all involved agencies are allowed to provide input.

All services and materials for this alternative are readily available.

Cost

The total present worth for Alternative 2 is approximately $611,762. The estimated capital cost is approximately $541,601, and the estimated O&M cost is approximately $70,161. Detailed cost estimates are in Appendix O.

11.1.2.3 <u>Alternative 3 -- Excavation and Revegetation/Restoration of Wetlands</u>

11.1.2.3.1 Option A - Regrading With Clean Fill

Overall Protection of Human Health and the Environment

Source control of surface runoff and sediment transport will effectively eliminate a source of loading of contaminants to the adjacent wetlands. The removal of the contamination from the site wetlands will effectively protect the environment. Removal will also reduce risk to ecological receptors.

The RAOs for reduction of risk to ecological receptors will be met and the alternative will restore the degraded wetlands' structure and function.

Compliance with ARARs

EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. In addition, EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. Specifically, when it is apparent that a proposed or potential Agency action is likely to impact a floodplain or wetlands, the public should be informed through appropriate public notice processes. Furthermore, if a proposed action is located in or affects a floodplain or wetlands, a floodplain/wetlands assessment shall be undertaken, and a statement of findings explaining why the proposed action must be located in or affect the floodplain or wetlands.

The Protection of Wetlands Order (40 CFR 6) requires that no adverse impacts to wetlands result from a remedial action. The wetlands revegetation component of this alternative includes a 2-to-1 creation-to-loss ratio to compensate for the loss of forested and scrub/shrub wetlands which is expected to meet the wetlands mitigation requirements of CWA Section 404.

The substantive requirements for stormwater discharges during construction activities as outlined by the CWA are relevant and appropriate. However, a specific NPDES permit is not required for this remedial action.

All action-specific ARARs are expected to be met. The TAPCR dust suppression and control requirements (Rule 1200-3-8) apply to earth-moving activities associated with this alternative. ARARs for the control of fugitive dust emissions would be met by applying water to roads receiving heavy vehicular traffic and to excavation areas, as necessary.

Long-Term Effectiveness and Permanence

This alternative provides source control and removal of contaminated sediments in the wetlands. This action would permanently remove contaminated sediments and thereby reduce risk to ecological receptors and improve water quality. The revegetation plan will restore the wetlands to a high functioning value which should support diverse ecological communities.

Reduction of M/T/V Through Treatment

Mobility, toxicity, and volume of contaminants will be reduced through removal, not through treatment.

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short-term and minimal. Short-term impacts are associated with excavation; however, these potential, short-term impacts would be mitigated during the wetlands restoration phase. The revegetation plan uses plant species which should restore the system within one growing season, thereby limiting the impacts. Controls can be implemented to reduce impacts on adjacent wetlands.

On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur during waste consolidation and grading. Dust emissions would be monitored at the property boundaries. Fugitive dust emissions would be controlled by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed. A measurable, short-term impact to the surrounding area would include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Short-term impact on biological communities in the wetlands caused by excavation will be notable because of excavation of wetlands sediment. However, the goal of the wetland mitigation program is to replace lost wetland vegetation so that wetland function and values either will be present immediately following the completion of mitigation or will develop over time. In addition, a consideration of breeding seasons, and control of erosion and sedimentation in terms of scheduling activities should ease short-term impact.

Implementability

All services and materials for this alternative are readily available. Moderate difficulty is posed by conducting operations in unstable sediment substrate. To avoid problems, excavation can be limited to dry periods. Revegetation will be performed in the spring and will require one month for completion.

Cost

The total present worth cost for Alternative 3, Option A is approximately $780,071. The estimated capital cost is $700,901. The estimated annual O&M cost is approximately $79,170. Detailed cost estimates are presented in Appendix O.

11.1.1.6.2 Option B - Regrading With Biosolid Compost Material

Overall Protection of Human Health and the Environment

Source control of surface runoff and sediment transport will effectively eliminate a source of loading of contaminants to the adjacent wetlands. The removal of the contamination from the site wetlands will effectively protect the environment. Removal will also reduce risk to ecological receptors.

The RAOs for reduction of risk to ecological receptors will be met and the alternative will restore the degraded wetlands' structure and function.

Compliance with ARARs

EPA's regulations (40 CFR Part 6, Appendix A)for implementing Executive Order 11988 (Floodplains Management) requires federal agencies to avoid or minimize adverse impacts of Federal actions upon floodplains, and to preserve and enhance the natural values of floodplains. Specifically, when it is apparent that a proposed or potential Agency action is likely to impact a floodplain or wetlands, the public should be informed through appropriate public notice processes. Furthermore, if a proposed action is located in or affects a floodplain or wetlands, a floodplain/wetlands assessment shall be undertaken, and a statement of findings explaining why the proposed action must be located in or affect the floodplain or wetlands.

The Protection of Wetlands Order (40 CFR 6) requires that no adverse impacts to wetlands result from a remedial action. The wetlands revegetation component of this alternative includes a 2-to-1 creation-to-loss ratio to compensate for the loss of forested and scrub/shrub wetlands which is expected to meet the wetlands mitigation requirements of CWA Section 404.

The substantive requirements for stormwater discharges during construction activities as outlined by the CWA are relevant and appropriate. However, a specific NPDES permit is not required for this remedial action.

All action-specific ARARs are expected to be met. The TAPCR dust suppression and control requirements (Rule 1200-3-8) apply to earth-moving activities associated with this alternative. ARARs for the control of fugitive dust emissions would be met by applying water to roads receiving heavy vehicular traffic and to excavation areas, as necessary.

Long-Term Effectiveness and Permanence

This alternative provides source control and removal of contaminated sediments in the wetlands. This action would permanently remove contaminated sediments and thereby reduce risk to ecological receptors and improve water quality. The revegetation plan will restore the wetlands to a high functioning value which should support diverse ecological communities.

Reduction of M/T/V Through Treatment

Mobility, toxicity, and volume of contaminants will be reduced through removal, not through treatment.

Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short-term and minimal. Short-term impacts are associated with excavation; however, these potential, short-term impacts would be mitigated during the wetlands restoration phase. The revegetation plan uses plant species which should restore the system within one growing season, thereby limiting the impacts. Controls can be implemented to reduce impacts on adjacent wetlands.

On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur during waste consolidation and grading. Dust emissions would be monitored at the property boundaries. Fugitive dust emissions would be controlled by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed. A measurable, short-term impact to the surrounding area would include increased vehicular traffic and associated safety hazards, potential dust generation, and noise.

Short-term impact on biological communities in the wetlands caused by excavation will be notable because of excavation of wetlands sediment. However, the goal of the wetland mitigation program is to replace lost wetland vegetation so that wetland function and values either will be present immediately following the completion of mitigation or will develop over time. In addition, a consideration of breeding seasons, and control of erosion and sedimentation in terms of scheduling activities should ease short-term impact.

Implementability

The use of biosolid compost material to address metals contamination is an emerging technology with limited full scale application. However, all services and materials for this alternative should be readily available.

Cost

The total present worth cost for Alternative 3, Option B is approximately $699,548. The estimated capital cost is $620,379. The estimated annual O&M cost is approximately $79,170. Detailed cost estimates are presented in Appendix O.

11.1.3 ANALYSIS OF GROUNDWATER ALTERNATIVES

11.1.3.1 Alternative 1 -- No Action

Overall Protection of Human Health and the Environment

The no action alternative does not eliminate any exposure pathways or reduce the level of risk of the existing groundwater contamination.

Compliance with ARARs

This alternative does not achieve the RAOs or chemical-specific ARARs established for groundwater. Location- and action-specific ARARs do not apply to this alternative since further remedial actions will not be conducted.

Long-Term Effectiveness and Permanence

The continued exposure of groundwater to onsite receptors and surface water is a potential long-term impact of this alternative. The remediation goals derived for protection of human health and the environment would not be met. Because contaminated groundwater remains under this alternative, a review/reassessment of the conditions at the site would be performed at 5-year intervals to ensure that the remedy does not become a greater risk to human health and the environment.

Reduction of M/T/V Through Treatment

No reductions of contaminant M/T/V are realized under this alternative.

Short-Term Effectiveness

Since on further remedial actions would be implemented at the site, this alternative poses no short-term risks to onsite workers. It is assumed that Level D personal protection would be used when sampling the various media.

Implementability

This alternative could be implemented immediately since monitoring equipment is readily available and procedures are in place.

Cost

The total present worth cost for this alternative is approximately $86,597. There are no capital costs are associated with this alternative. Detailed cost estimates are presented in Appendix O.

11.1.3.2 Alternative 2 -- Limited Action

Overall Protection of Human Health and the Environment

Unless the contingency treatment component is implemented, the limited action alternative does not eliminate any exposure pathways and only minimally reduces the level of risk through restrictions designed to prevent access and exposure to groundwater by limiting the type of activities that can take place at the site.

Compliance with ARARs

Unless the contingency treatment component is implemented, this alternative does not achieve the RAOs or chemical-specific ARARs established for groundwater. Location- and action-specific ARARs would not apply to this alternative since further remedial actions will not be conducted (unless the contingency treatment component is implemented.)

Long-Term Effectiveness and Permanence

The continued exposure of groundwater to onsite receptors and surface water is a potential long-term impact of this alternative. Unless the contingency treatment component of this alternative is implemented, the remediation goals derived for protection of human health and the environment would not be met. Because contaminated groundwater remains under this alternative, a review/reassessment of the conditions at the site would be performed at 5-year intervals to ensure that the remedy does not become a greater risk to human health and the environment.

Reduction of M/T/V Through Treatment

No reductions of contaminant M/T/V are realized under this alternative.

Short-Term Effectiveness

Since no further remedial actions would be implemented at the site (i.e. the contingency treatment is not implemented), this alternative poses no short-term risks to onsite workers. It is assumed that Level D personal protection would be used when sampling the various media.

Implementability

This alternative could be implemented immediately since monitoring equipment is readily available and procedures are in place.

Cost

The total present worth cost for this alternative is approximately $498,095. Capital cost associated with this alternative is $130,295 and O&M costs are $367,800. Detailed cost estimates are presented in Appendix O.

11.1.3.3 Alternative 3A/B/C/D -- Pump & Treat with Physical and/or Chemical Treatment

Overall Protection of Human Health and the Environment

Treatment of contaminated groundwater virtually eliminates all risks associated with the exposure pathways. Extraction of contaminated groundwater would block contaminated groundwater from moving into the wetlands and thus discharging into the surface water downgradient of the site. Treatability studies would ensure that the selected treatment system could remediate groundwater contaminant concentrations to meet remediation goals.

Compliance with ARARs

Implementation of this alternative would meet chemical-specific ARARs by reducing contaminant concentrations to levels below federal MCLs and lead concentrations below the EPA action level.

No conflicts with location-specific ARARs are expected for the implementation of this alternative.

All action-specific ARARs are expected to be met. The TAPCR dust suppression and control requirements (Rule 1200-3-8) apply to activities, such as trenching, associated with this alternative. ARARs for the control of fugitive dust emissions would be met by applying water to roads receiving heavy vehicular traffic and to trenching areas, if as necessary.

Long-Term Effectiveness and Permanence

The pump-and-treat system will have to be maintained to ensure that it continues to perform as designed; consequently, monitoring, inspection, and maintenance would be required. The system may be susceptible to fouling, clogging, or other mechanical failure, and it may also require periodic disposal of sludge generated during treatment. However, the system would be inspected on a regular schedule, and required maintenance could be implemented.

Monitoring would be required until all groundwater monitoring points indicate that contaminant concentrations are below action levels or MCLs.

Pump-and-treat, in conjunction with source control activities, is a long-term solution because it would permanently reduce contaminant concentrations in groundwater. Using precipitation/flocculation/coagulation and sedimentation as a basis, the length of time required to achieve remediation would range from 4 to 11 years, depending on the pumping scenario selected.

Reduction of M/T/V Through Treatment

The primary objective of this alternative is to reduce contaminant volume by removing contaminated groundwater from the site. Removal would also eliminate migration of contaminated groundwater from the site.

Short-Term Effectiveness

The construction phase of this alternative would most likely be accomplished within 2 to 8 weeks, depending on the scenario selected. However, implementation of the preferred removal action alternative for contaminated solid media would be required before installing the pump-and-treat system. A groundwater treatability study may be needed before installing the pump-and-treat system, delaying selection of this alternative.

On-site workers would be adequately protected from short-term risks by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur during drilling and trenching. Dust emissions would be monitored at the property boundaries. Control of fugitive dust emissions would be provided by applying water as needed to surfaces receiving heavy vehicular traffic or in trenching areas.

Implementability

The technical feasibility of this alternative would have to be evaluated in a treatability study if this alternative is preferred. The study would be required to design an appropriate treatment system.

Construction of the pump-and-treat system uses standard construction practices and equipment. No significant construction issues are expected to be encountered.

The technical feasibility of this alternative also depends on the removal action alternative selected for contaminated solid media. A sitewide disposal area, as proposed in Soil Alternatives 2, 3, 4, and 6a, may preclude the use or require modification of the pump-and-treat system as proposed in this alternative.

Wastewater may be generated during implementation of this alternative through water runoff generated as a result of dust emission control. Wastewater may also be generated as a result of decontamination activities required for equipment and on-site workers. Containment and treatment or disposal of these wastewaters may be required.

No state or federal permits are expected to be required; however, advance consultation should occur in planning the action to ensure that all involved agencies are allowed to provide input.

All services and materials for this alternative are readily available.

Cost

Using precipitation/flocculation/coagulation and sedimentation treatment as a basis, the total present worth for Alternative 3A is approximately $1,359,116. The estimated capital cost is approximately $349,559 and the estimated O&M cost is approximately $1,009,557.
Detailed cost estimates are in Appendix O.

The total present worth for Alternative 3B is approximately $1,185,719. The estimated capital cost is approximately $355,879 and the estimated O&M cost is approximately $829,900.
Detailed cost estimates are in Appendix O.

The total present worth for Alternative 3C is approximately $867,484. The estimated capital cost is approximately $362,078 and the estimated O&M cost is approximately $505,406. Detailed cost estimates are in Appendix O.

The total present worth for Alternative 3D is approximately $1,652,450. The estimated capital cost is approximately $440,397 and the estimated O&M cost is approximately $1,212,053. Detailed cost estimates are in Appendix O.

12.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents a comparative analysis of the surface soil/sediment and groundwater alternatives based on the threshold and balancing evaluation criteria. The objective of this section is to compare and contrast the alternatives so that decision makers may select a preferred alternative for presentation in the Record of Decision.

The alternatives are presented here to give decision makers a range of potential actions that could be taken to remediate this site. These actions include:

Soil	No Action (Alternative 1) Capping (Alternatives 2, 3, 4, and 6) Solidification/Stabilization (Alternatives 5 and 6)
Wetland Sediment	No Action (Alternative 1) Capping and Off-site Creation of Wetlands (Alternative 2) Excavation, Regrading and Wetlands Revegetation/Restoration (Alternative 3)
Groundwater	No Action (Alternative 1) Limited Action (Alternative 2) Pump and Treat-(Alternative 3)

For groundwater alternative 3, scenarios A,B,C, and D refer to four different pumping configurations. Scenarios A,B, and C are based on a single plume of lead emanating from the wrecker building area. Scenario D is based on a consideration of the entire site as a potential source.

Tables 12-1 through 12-3 present a summary of each remedial alternative along with ranking scores for each evaluation criterion. Each alternative's performance against the criteria (except for present worth) was ranked on a scale of 0 to 5, with 0 indicating that none of the criterion's requirements were met and 5 indicating all of the requirements were met. The ranking scores are

Table 12-1
Comparative Analysis of Soil Alternatives
Ross Metals Site
Rossville, Tennessee

Remedial Alternative	Criteria Rating [1]						Approximate Present Worth ($)
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability	
1 -- No Action	0	0	0	0	5	5	$100,247
2 -- Capping	4	4	2	3	4	3	Opt.1-$1,735,804 Opt.2-$1,712,412
3 -- Capping With Pavement In Place	4	4	3	3	4	3	Opt.1-$1,453,803 Opt.2-$1,430,411
4 -- Capping With Construction of Above-Ground Disposal Cell	4	4	3	3	4	3	Opt.1-$1,506,847 Opt.2-$1,481,865
5A -- Excavation and Onsite Treatment With S/ S and onsite Disposal	5	4	4	5	4	3	Opt.1-$4,907,274 Opt.2-$4,244,992
5B -- Excavation and Onsite Treatment With S/S and offsite Disposal	5	5	5	5	4	4	Opt.1-$7,477,199 Opt.2-$6,181,160
6A -- Capping With Excavation & Onsite Treatment of Princ. Thrt Waste & onsite disposal	5	4	4	5	4	3	Opt.1-$3,175,137 Opt.2-$2,729,543
6B -- Capping With Excavation & Onsite Treatment and Offsite Disposal of Principal Threat Waste	5	4	4	5	4	3	Opt.1-$4,936,044 Opt.2-$4,013,508

[1]A ranking of “0" indicates noncompliance, while a ranking of “5" indicates complete compliance. Opt. 1 includes excavated wetland sediment; Opt. 2 does not.

Table 12-2

Comparative Analysis of Wetland Sediment Alternatives
Ross Metals Site
Rossville, Tennessee

Remedial Alternative	Criteria Rating [1]						Approximate Present Worth ($)
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectivenes s	Implementabilit y	
1 -- No Action	0	0	0	0	5	5	$100,247
2 -- Capping with Off-site Creation of Wetlands	3	2	2	3	3	4	$611,762
3 A -- Excavation, Regrading with Clean Fill and Wetlands Revegetation/ Restoration	5	5	5	4	4	4	$780,071
3 B -- Excavation, Regrading with Biosolid Compost Material and Wetlands Revegetation/ Restoration	5	5	5	5	4	3	$699,548

[1]A ranking of “0" indicates noncompliance, while a ranking of “5" indicates complete compliance.

Table 12-3

Comparative Analysis of Groundwater Alternatives
Ross Metals Site
Rossville, Tennessee

Remedial Alternative	**Criteria Rating [1]**						**Approximate Present Worth ($)**
	Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-Term Effectiveness and Permanence**	**Reduction of M/T/V Through Treatment**	**Short-Term Effectivenes s**	**Implementabilit y**	
1 -- No Action	0	0	0	0	5	5	$86,597
2 -- Limited Action	1	0	0	0	5	5	$498,095
3 A/B /C/D-- Pump & Treat w/ Physical/Chemical Treatment	5	5	5	5	4	4	A-$1,359,116 B-$1,185,719 C- $867,487 D-$1,652,450

[1]A ranking of “0" indicates noncompliance, while a ranking of “5" indicates complete compliance.
Scenarios A,B, C, and D refer to four different extraction system setups.

not intended to be quantitative or additive, rather they are only summary indicators of each alternative's performance against the CERCLA evaluation criteria. The ranking scores combined with the present worth costs provide the basis for comparison among alternatives.

For soil, Alternatives 2 through 7 all rank higher than Alternative 1 in overall protection of human health and the environment, compliance with ARARs, long-term effectiveness and permanence, and reduction of M/T/V. The three capping alternatives, Alternatives 2, 3, and 4, are ranked similarly with the exception that Alternative 2 ranks lowest in long-term effectiveness and permanence. The two treatment alternatives receive similar ranking in all criteria with the exception Option B of Alternative 5 ranks highest in compliance with ARARs long-term effectiveness and permanence, and implementability. A comparison of the capping alternatives to the treatment alternatives indicates that the treatment alternatives (Alternatives 5 and 6) rank slightly higher than the capping alternatives (Alternatives 2, 3, and 4) in overall protection of human health and the environment and reduction of M/T/V, but are more costly.

For wetland sediment, both Alternatives 2 and 3 rank higher than Alternative 1 in overall protection of human health and the environment, compliance with ARARs, long-term effectiveness and permanence, and reduction of M/T/V. Both options under Alternative 3 (Excavation, Regrading and Wetlands Revegetation) rank higher than Alternative 2 (Capping and Off-site Creation of Wetlands) in overall protection of human health and the environment, compliance with ARARs, long-term effectiveness and permanence, and reduction of M/T/V.

For groundwater, Alternative 3 ranks higher than Alternatives 1 and 2, in overall protection of human health and the environment, compliance with ARARs, long-term effectiveness and permanence, and reduction of M/T/V. Note that the rankings for Alternative 3 are based on the results of the original Random-Walk Modeling completed as part of the EE/CA for the RM site. The revised model completed for this FS suggests that none of the pump and treat scenarios developed for the RM site would achieve the RGO level for lead in groundwater, even after 100 years (See Appendix K). The selection of a specific pump & treat alternative would be based on the outcome of treatability testing and additional modeling to better define aquifer and plume properties, and ensure technical practicability.

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TABLE 1

SELECTION OF EXPOSURE PATHWAYS

ROSS METALS SITE

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Soil	Soil	Landfill Area	Trespasser/visitor	Adolescents	Ingestion	On-site	Quant.	Landfill is accessible to site visitors who may accidentally ingest soil.
						Dermal	On-site	Quant.	Landfill is accessible to site visitors who may come into contact with soil.
		Air				Inhalation	On-site	Quant.	Landfill is accessible to site visitors who may inhale dust released from soil.
	Soil	Soil	Wetland/Woodland Area	Trespasser/visitor	Adolescents	Ingestion	On-site	Quant.	Wetland is accessible to site visitors who may accidentally ingest soil.
						Dermal	On-site	Quant.	Wetland is accessible to site visitors who may come into contact with soil.
		Air				Inhalation	On-site	Quant.	Wetland is accessible to site visitors who may inhale dust released from soil.
		Surface water				Ingestion	On-site	Quant.	Wetland is accessible to site visitors who may accidentally ingest water.
						Dermal	On-site	Quant.	Wetland is accessible to site visitors who may come into contact with water.
Future	Soil	Soil	Process Area	Worker	Adult	Ingestion	On-site	Quant.	Site workers may accidentally ingest Process Area soil.
						Dermal	On-site	Quant.	Site workers may come into contact with Process Area soil.
		Air				Inhalation	On-site	Quant.	Site workers may inhale dust released from Process Area soil.
		Soil	Process Area	Resident	Child	Ingestion	On-site	Quant.	Site residents may accidentally ingest Process Area soil.
						Dermal	On-site	Quant.	Site residents may come into contact with Process Area soil.
		Air				Inhalation	On-site	Quant.	Site residents may inhale dust released from Process Area soil.
		Soil	Process Area	Resident	Adult	Ingestion	On-site	Quant.	Site residents may accidentally ingest Process Area soil.
						Dermal	On-site	Quant.	Site residents may come into contact with Process Area soil.
		Air				Inhalation	On-site	Quant.	Site residents may inhale dust released from Process Area soil.
	Soil	Soil	Landfill Area	Worker	Adult	Ingestion	On-site	Quant.	Site workers may accidentally ingest Landfill Area soil.
						Dermal	On-site	Quant.	Site workers may come into contact with Landfill Area soil.
		Air				Inhalation	On-site	Quant.	Site workers may inhale dust released from Landfill Area soil.
		Soil	Landfill Area	Resident	Child	Ingestion	On-site	Quant.	Site residents may accidentally ingest Landfill Area soil.
						Dermal	On-site	Quant.	Site residents may come into contact with Landfill Area soil.
		Air				Inhalation	On-site	Quant.	Site residents may inhale dust released from Landfill Area soil.
		Soil	Landfill Area	Resident	Adult	Ingestion	On-site	Quant.	Site residents may accidentally ingest Landfill Area soil.
						Dermal	On-site	Quant.	Site residents may come into contact with Landfill Area soil.
		Air				Inhalation	On-site	Quant.	Site residents may inhale dust released from Landfill Area soil.
	Groundwater	Groundwater	Process Area	Resident	Child	Ingestion	On-site	Quant.	Groundwater may be used as a drinking water source in the future.
				Resident	Adult	Ingestion	On-site	Quant.	Groundwater may be used as a drinking water source in the future.
				Worker	Adult	Ingestion	On-site	Quant.	Groundwater may be used as a drinking water source in the future.
	Groundwater	Groundwater	Landfill Area	Resident	Child	Ingestion	On-site	Quant.	Groundwater may be used as a drinking water source in the future.
				Resident	Adult	Ingestion	On-site	Quant.	Groundwater may be used as a drinking water source in the future.
				Worker	Adult	Ingestion	On-site	Quant.	Groundwater may be used as a drinking water source in the future.

TABLE 2.1.1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
ROSS METALS SITE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Process Area

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	(2) Background Value	(3) Screening Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	(4) Rationale for Contaminant Deletion or Selection
7429-90-5	Aluminum	350		15,000		mg/kg	17SLA	21/21	NA	15,000	11,620	7,800	N	NA	NA	N	BKG
1314-60-9	Antimony	7	J	730	J	mg/kg	13SLA	9/25	2.7-20	730	2.1	3.1	N	NA	NA	Y	ASL
7440-38-2	Arsenic	3		479		mg/kg	Sump	25/26	2	479	5	0.45	C	NA	NA	Y	ASL
7440-39-3	Barium	19		790		mg/kg	16SLA	21/21	NA	790	95	550	N	NA	NA	Y	ASL
7440-41-7	Beryllium	0.4		0.4		mg/kg	3SLA	1/21	0.06-1	0.4	0.4	0.15	C	NA	NA	N	BKG
7440-43-9	Cadmium	0.1	B	99		mg/kg	Sump	16/26	0.05-1	99	0.4	4	N	NA	NA	Y	ASL
7440-70-2	Calcium	441		353,000	J	mg/kg	6SLA	26/26	NA	353,000	1,319	NA		NA	NA	N	NUT
185040-29-9	Chromium	3		21		mg/kg	Sump	21/21	NA	21	14	39	N	NA	NA	N	BSL
7440-48-4	Cobalt	3		13		mg/kg	18SLA	3/21	1-8	13	7	470	N	NA	NA	N	BSL
7440-50-8	Copper	6		712		mg/kg	Sump	18/21	1-5	712	12	310	N	NA	NA	Y	ASL
7439-89-6	Iron	1	J	30,100		mg/kg	Sump	23/26	2.4-3.5	30,100	16,100	2,300	N	NA	NA	N	BKG
7439-92-1	Lead	6	J	97,700		mg/kg	Sump	29/29	NA	97,700	30	400	N	NA	NA	Y	ASL
7439-95-4	Magnesium	39	J	15,000		mg/kg	6SLA	26/26	NA	15,000	1,390	NA		NA	NA	N	NUT
7439-96-5	Manganese	2	J	560		mg/kg	13SLA	26/26	NA	560	559	180	N	NA	NA	N	BKG
7439-97-6	Mercury	1		1		mg/kg	Sump	1/21	0.11-0.13	1	0.1	2	N	NA	NA	N	BSL
7440-02-0	Nickel	11		127		mg/kg	Sump	9/21	1-9	127	11	160	N	NA	NA	N	BSL
7440-09-7	Potassium	15	B	2,300		mg/kg	15SLA	16/26	160-420	2300	805	NA		NA	NA	N	NUT
7782-49-2	Selenium	1		48		mg/kg	Sump	7/21	0.8-2	48	3	39	N	NA	NA	Y	ASL
7440-22-4	Silver	1		11		mg/kg	6SLA	3/21	0.64-2	11	1	39	N	NA	NA	N	BSL
7440-23-5	Sodium	249		4,040		mg/kg	16-00M	10/26	90-460	4040	97	NA		NA	NA	N	NUT
563-68-8	Thallium	6		6		mg/kg	Sump	1/21	1-2	6	7	1	N	NA	NA	N	BSL
7440-62-2	Vanadium	8	J	28		mg/kg	17SLA	20/21	NA	28	27	55	N	NA	NA	N	BSL
7440-66-6	Zinc	14		629		mg/kg	Sump	21/21	NA	629	43	2,300	N	NA	NA	N	BSL

(1) Minimum/maximum detected concentration.

(2) Background: average of samples BK-1, BK-2 and Ref. 1 using one-half the SQL for non-detects.

(3) Risk-based concentrations for residential soil obtained from: "Risk-Based Concentration Table, " Roy L Smith, Ph.D., EPA Region III Senior Toxicologist. Obtained on-line 4/23/98. Units are mg/kg.

(4) Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Level (BSL)
Background Levels (BKG)

Definitions:
N/A = Not Applicable
SQL = Sample Quantitation Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
MCL = Federal Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic

TABLE 2.1.2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
ROSS METALS SITE

Scenario Timeframe: Current
Medium: Soil
Exposure Medium: Soil
Exposure Point: Landfill Area

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	(2) Background Value	(3) Screening Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	(4) Rationale for Contaminant Deletion or Selection
7429-90-5	Aluminum	3,300		14,000		mg/kg	022SLA	4/4	NA	14,000	11,620	7,800	N	NA	NA	N	BKG
1314-60-9	Antimony	75	J	75	J	mg/kg	111SLA	1/4	10-10	75	2	3.1	N	NA	NA	Y	ASL
7440-38-2	Arsenic	8		76	J	mg/kg	111SLA	4/4	NA	76	5	0.43	C	NA	NA	Y	ASL
7440-39-3	Barium	77		140		mg/kg	022SLA	4/4	NA	140	95	550	N	NA	NA	N	BSL
7440-43-9	Cadmium	1		22		mg/kg	111SLA	3/4	NA	22	0.4	4	N	NA	NA	Y	ASL
7440-70-2	Calcium	3,800	J	43,000	J	mg/kg	111SLA	4/4	NA	43,000	1,319	NA		NA	NA	N	NUT
185040-29-9	Chromium	12		17	J	mg/kg	111SLA	4/4	NA	17	14	39	N	NA	NA	N	BSL
7440-48-4	Cobalt	14	J	14	J	mg/kg	110SLA	1/4	2.5-4.5	14	7	470	N	NA	NA	N	BSL
7440-50-8	Copper	14		63		mg/kg	111SLA	4/4	NA	63	12	310	N	NA	NA	N	BSL
7439-89-6	Iron	15,000		20,000		mg/kg	111SLA	4/4	NA	20,000	16,100	2,300	N	NA	NA	N	BKG
7439-92-1	Lead	35		42,400		mg/kg	T4-LF/B12	11/11	NA	42,400	30	400		NA	NA	Y	ASL
7439-95-4	Magnesium	920		3,100		mg/kg	111SLA	4/4	NA	3,100	1,390	NA		NA	NA	N	NUT
7439-96-5	Manganese	380		1,100		mg/kg	110SLA	4/4	NA	1,100	559	180	N	NA	NA	Y	ASL
7439-97-6	Mercury	0.3		0.3		mg/kg	111SLA	1/4	0.055	0.3	0.1	2.3	N	NA	NA	N	BSL
7440-02-0	Nickel	14		18		mg/kg	111SLA	3/4	10	18	11	160	N	NA	NA	N	BSL
7440-09-7	Potassium	480		800		mg/kg	111SLA	3/4	440	800	805	NA		NA	NA	N	NUT
7782-49-2	Selenium	6.2		6.2		mg/kg	111SLA	1/4	0.38-0.485	6	3	39	N	NA	NA	N	BSL
7440-23-5	Sodium	1,800		1,800		mg/kg	110SLA	1/4	180-255	1,800	97	NA		NA	NA	N	NUT
7440-62-2	Vanadium	13		30		mg/kg	022SLA	4/4	NA	30	27	55	N	NA	NA	N	BSL
7440-66-6	Zinc	45	J	310	J	mg/kg	110SLA	4/4	NA	310	43	2300	N	NA	NA	N	BSL

(1) Minimum/maximum detected concentration.

(2) Background: average of samples BK-1, BK-2 and Ref. 1 using one-half the SQL for non-detects.

(3) Risk-based concentrations for residential soil obtained from: "Risk-Based Concentration Table, " Roy L Smith, Ph.D., EPA Region III Senior Toxicologist. Obtained on-line 4/23/98. Units are mg/kg.

(4) Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Level (BSL)

Definitions: N/A = Not Applicable
SQL = Sample Quantitation Limit
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
MCL = Federal Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic

TABLE 2.1.3
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
ROSS METALS SITE

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Wetland/Woodland Area

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
7429-90-5	Aluminum	3,390		24,000		mg/kg	RM-6-S	46/46	NA	24,000	11,620	7,800 N	NA	NA	Y	Y
1314-60-9	Antimony	1		1,350		mg/kg	Location 3	14/42	3.8-20	1350	2	3.1 N	NA	NA	Y	Y
7440-38-2	Arsenic	4		681		mg/kg	Location 3	46/46	NA	681	5	0.43 C	NA	NA	Y	Y
7440-39-3	Barium	53		610		mg/kg	68SLA	46/46	NA	610	95	550 N	NA	NA	Y	Y
7440-41-7	Beryllium	0.3		0.8		mg/kg	Location 12	3/46	0.1-2	0.8	0.4	0.15 C	NA	NA	N	BKG
7440-43-9	Cadmium	1		18		mg/kg	Location 12	28/46	0.3-2	18	0.4	3.9 N	NA	NA	Y	Y
7440-70-2	Calcium	230		8,900		mg/kg	66SLA	44/46	300-870	8,900	1,319	NA	NA	NA	N	NUT
185040-29-9	Chromium	5		28		mg/kg	68SLA	46/46	NA	28	14	39 N	NA	NA	N	BSL
7440-48-4	Cobalt	2		8		mg/kg	RM-8	13/46	1.9-20	8	7	470 N	NA	NA	N	BSL
7440-50-8	Copper	8		465		mg/kg	Location 12	45/46	20	465	12	310 N	NA	NA	Y	Y
7439-89-6	Iron	4,790		40,000		mg/kg	68SLA	46/46	NA	40,000	16,100	2,300 N	NA	NA	Y	Y
7439-92-1	Lead	67		98,100		mg/kg	Location 3	52/52	NA	98,100	30	400	NA	NA	Y	Y
7439-95-4	Magnesium	378		2,800		mg/kg	65SLA	46/46	NA	2,800	1,390	NA	NA	NA	N	NUT
7439-96-5	Manganese	25	J	1,500	J	mg/kg	65SLA	46/46	NA	1,500	559	180 N	NA	NA	Y	Y
7439-97-6	Mercury	0.1		1.1		mg/kg	Location 3	13/46	0.13-0.29	1.1	0.1	2.3 N	NA	NA	N	BSL
7440-02-0	Nickel	4		35		mg/kg	Location 12	18/46	0.82-40	35	11	160 N	NA	NA	N	BSL
7440-09-7	Potassium	244		2,190		mg/kg	Location 3	31/46	340-1800	2190	805	NA	NA	NA	N	NUT
7782-49-2	Selenium	1.5		84		mg/kg	Location 3	13/46	0.74-16	84	3	39 N	NA	NA	Y	Y
7440-22-4	Silver	2.1		2.1		mg/kg	Location 3	1/46	0.15-4	2.1	1	39 N	NA	NA	N	BSL
7440-23-5	Sodium	270		1,300		mg/kg	SS-2-1	8/46	50-670	1300	97	NA	NA	NA	N	NUT
7440-22-6	Strontium	12		21		mg/kg	RM-6-S	8/8	NA	21	11	4,700 N	NA	NA	N	BSL
7440-31-5	Tin	10		18		mg/kg	SS-2-4	5/8	5-10	18	5	4,700 N	NA	NA	N	BSL
13463-67-7	Titanium	79		410		mg/kg	RM-8	8/8	NA	410	350	31,000 N	NA	NA	N	BSL
7440-62-2	Vanadium	10.4		63		mg/kg	68-SLA	46/46	72	63	27	55 N	NA	NA	Y	Y
7440-65-5	Yttrium	5		12		mg/kg	RM-6-S	8/8	NA	12	8	39 N	NA	NA	N	BSL
7440-66-6	Zinc	21		251		mg/kg	Location 12	44/46	50-60	251	43	2,300 N	NA	NA	N	BSL
206-44-0	Fluoranthene	100	J	100	J	ug/kg	Location 3	1/2	450	100	NA	310,000 N	NA	NA	N	BSL
129-0-0	Pyrene	110	J	110	J	ug/kg	Location 3	1/2	450	110	NA	230,000 N	NA	NA	N	BSL
85-68-7	Butylbenzylphthalate	120	J	120	J	ug/kg	Location 12	1/2	650	120	NA	1,600,000 N	NA	NA	N	BSL
117-81-7	Bis(2-Ethylhexyl)phthalate	1,000		2,400		ug/kg	Location 12	2/2	NA	2400	NA	46,000 C	NA	NA	N	BSL
218-01-9	Chrysene	220	J	220	J	ug/kg	Location 3	1/2	450	220	NA	88,000 C	NA	NA	N	BSL
205-99-2	Benzo(k)fluoranthene	74	J	74	J	ug/kg	Location 3	1/2	450	74	NA	8,800 C	NA	NA	N	BSL
50-32-8	Benzo(a)pyrene	66	J	66	J	ug/kg	Location 3	1/2	450	66	NA	88 C	NA	NA	N	BSL
67-64-1	Acetone	30	B	30	B	ug/kg	Location 12	1/2	18	30	NA	780,000 N	NA	NA	N	BSL
78-93-3	2-Butanone	10		10		ug/kg	Location 3	1/2	14.4	10	NA	4,700,000 N	NA	NA	N	BSL
104-51-8	n-Butylbenzene	25	J	25	J	ug/kg	Location 12	1/2	9.2	25	NA	78,000 N	NA	NA	N	BSL
135-98-8	sec-Butylbenzene	4	J	4	J	ug/kg	Location 12	1/2	9.2	4	NA	78,000 N	NA	NA	N	BSL
100-41-4	Ethylbenzene	55	J	55	J	ug/kg	Location 12	1/2	9.2	55	NA	780,000 N	NA	NA	N	BSL
98-82-8	Isopropylbenzene	7.8	J	7.8	J	ug/kg	Location 12	1/2	9.2	7.8	NA	78,000 N	NA	NA	N	BSL

TABLE 2.1.3
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
ROSS METALS SITE

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Wetland/Woodland Area

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	(2) Background Value	(3) Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	(4) Rationale for Contaminant Deletion or Selection
750-9-2	Methylene chloride	6	JB	11	JB	ug/kg	Location 3	2/2	NA	11	NA	85,000 C	NA	NA	N	BSL
91-20-3	Naphthalene	20	B	20	B	ug/kg	Location 12	1/2	9.2	20	NA	310,000 N	NA	NA	N	BSL
95-47-6	o-Xylene	61		61		ug/kg	Location 12	1/2	9.2	61	NA	16,000,000 N	NA	NA	N	BSL
1330-20-7	p & m Xylene	230		230		ug/kg	Location 12	1/2	9.2	230	NA	16,000,000 N	NA	NA	N	BSL
103-65-1	n-Propylbenzene	39		39		ug/kg	Location 12	1/2	9.2	39	NA	78,000 N	NA	NA	N	BSL
108-88-3	Toluene	55		55		ug/kg	Location 12	1/2	9.2	55	NA	1,600,000 N	NA	NA	N	BSL
95-63-6	Trimethylbenzene, 1,2,4-	190		190		ug/kg	Location 12	1/2	18	190	NA	390,000 N	NA	NA	N	BSL
108-67-8	Trimethylbenzene, 1,3,5-	55		55		ug/kg	Location 12	1/2	9.2	55	NA	390,000 N	NA	NA	N	BSL

(1) Minimum/maximum detected concentration.

(2) Background: average of samples BK-1, BK-2 and Ref. 1 using one-half the SQL for non-detects.

(3) Risk-based concentrations for residential soil obtained from: "Risk-Based Concentration Table, " Roy L Smith, Ph.D., EPA Region III Senior Toxicologist. Obtained on-line 4/23/98. Units are mg/kg.

(4) Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Background Levels (BKG)
Essential Nutrient (NUT)
Below Screening Level (BSL)

Definitions:
N/A = Not Applicable
SQL = Sample Quantitation Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
MCL = Federal Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
J = Estimated Value
N = Non-Carcinogenic

TABLE 2.1.4
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
ROSS METALS SITE

Scenario Timeframe: Current/Future
Medium: Surface water
Exposure Medium: Surface water
Exposure Point: Wetland/Woodland Area

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	(2) Background Value	Screening Toxicity Value (3,4,5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	(6) Rationale for Contaminant Deletion or Selection
7429-90-5	Aluminum	168		1,300		ug/l	SW-04	7/10	170-200	1,300	165	87 3	87	AWQC	Y	ASL
1314-60-9	Antimony	8		150		ug/l	Location 2	7/10	60	150	30	14 4	14	AWQC	Y	ASL
7440-38-2	Arsenic	18		554		ug/l	Location 2	9/10	5	554	4	0.018 4	0.018	AWQC	Y	ASL
7440-39-3	Barium	41		240		ug/l	079SW	10/10	NA	240	58	1,000 4	1,000	AWQC	N	BSL
7440-43-9	Cadmium	6		120		ug/l	SW-02	6/10	0.5-5	120	1	0.66 3	0.66	AWQC	Y	ASL
7440-70-2	Calcium	14,300		110,000		ug/l	SW-05	10/10	NA	110,000	32,000	NA	NA	NA	N	NUT
7440-48-4	Cobalt	8		40		ug/l	Location 15	3/10	2.5-3.5	40	3	220 5	220	NA	N	BSL
7440-50-8	Copper	6		140		ug/l	SW-05	9/10	2	140	4	6.54 3	6.54	AWQC	Y	ASL
7439-89-6	Iron	313		42,700		ug/l	Location 2	10/10	NA	42,700	6,800	300 4	300	AWQC	Y	ASL
7439-92-1	Lead	36		16,000		ug/l	SW-04	10/10	NA	16,000	9	1.32 3	1.32	AWQC	Y	ASL
7439-95-4	Magnesium	3,160		7,500		ug/l	SW-04	10/10	NA	7,500	4,500	NA	NA	NA	N	NUT
7439-96-5	Manganese	229		5,520		ug/l	Location 15	10/10	NA	5,520	840	50 4	50	AWQC	Y	ASL
7439-97-6	Mercury	0.2	J	0.4	J	ug/l	SW-04	4/10	0.05	0.4	0	0.012 4	0.012	AWQC	Y	ASL
7440-02-0	Nickel	7		44		ug/l	Location 2	4/10	5-60	44	45	610 4	610	AWQC	N	BSL
7440-09-7	Potassium	2		2,700		ug/l	079SW	6/10	8300-14000	2700	2,450	NA	NA	NA	N	N/NUT
7782-49-2	Selenium	7	J	11		ug/l	Location 2	2/10	4-5	11	2	5 3	5	AWQC	Y	ASL
7440-23-5	Sodium	4		110,000		ug/l	SW-04	10/10	NA	110000	1,900	NA	NA	NA	N	NUT
563-68-9	Thallium	13		13		ug/l	Location 2	3/10	5-6	13.4	3	1.7 4	2	AWQC	Y	ASL
7440-62-2	Vanadium	3	J	8		ug/l	Location 2	3/10	3-4	8	2	26 5	26	NA	N	BSL
7440-66-6	Zinc	39		568		ug/l	Location 2	7/10	50-100	568	30	58.91 3	59	AWQC	Y	ASL

(1) Minimum/maximum detected concentration.

(2) Background: SW-1 collected 6/95, using one-half the SQL for non-detects.

(3) AWQC, Freshwater Aquatic Life Criteria, water and organism consumption. Units are ug/l.

(4) AWQC, Human Health Criteria. Units are ug/l.

(5) Risk-based concentrations for tap water obtained from: "Risk-Based Concentration Table, " Roy L Smith, Ph.D., EPA Region II Senior Toxicologist. Obtained on-line 4/23/98. Units are ug/l.

Definitions: N/A = Not Applicable
SQL = Sample Quantitation Limit
N = Non-Carcinogenic

TABLE 2.1.5
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
ROSS METALS SITE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Process Area

CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	(2) Background Value	(3) Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	(4) Rationale for Contaminant Deletion or Selection
7429-90-5	Aluminum	380		23,000		ug/l	17TW	9/14	20-160	23,000	35	3,700 N	200	SMCL	Y	ASL
7440-38-2	Arsenic	21		40		ug/l	16TW	2/24	5-75	40	3	0.045 C	50	MCL	Y	ASL
7440-39-3	Barium	11		380		ug/l	18TW	14/14	NA	380	16	260 N	2000	MCL	Y	ASL
7440-43-9	Cadmium	5		7		ug/l	10TW	3/14	2	7	1	1.8 N	5	MCL	Y	ASL
7440-70-2	Calcium	2,600	J	110,000	J	ug/l	17TW	14/14	NA	110,000	3,300	NA	NA	NA	N	NUT
1854-02-99	Chromium	39		39		ug/l	17TW	1/14	6-7		3	18 N	100	MCL	Y	ASL
7440-48-4	Cobalt	55		55		ug/l	16TW	1/14	2-50	55	1	220 N	NA	NA	N	NUT
7439-89-6	Iron	1,300	J	64,000	J	ug/l	16TW	10/14	40-470	64,000	20	1,100 N	300	SMCL	Y	ASL
7439-92-1	Lead	3	J	1,600		ug/l	GW-12	18/24	2-4	1,600	2	15	15	AL	Y	ASL
7439-95-4	Magnesium	1,100		38,000		ug/l	17TW	13/14	NA	38,000	1,300	NA	NA	NA	N	NUT
7439-96-5	Manganese	130		5,600		ug/l	17TW	10/14	3-9	5,600	3	84 N	50	SMCL	Y	ASL
7440-02-0	Nickel	45		160		ug/l	15TW	4/14	3-20	160	2	73 N	100	MCL	Y	ASL
7440-09-7	Potassium	450		4,400		ug/l	17TW	14/14	NA	4400	700	NA	NA	NA	N	NUT
7440-23-5	Sodium	5,900		490,000		ug/l	16TW	14/14	NA	490000	11,000	NA	NA	NA	N	NUT
7440-62-2	Vanadium	7	J	49	J	ug/l	17TW	3/14	3-6	49	2	26 N	NA	NA	Y	ASL
7440-66-6	Zinc	28		240		ug/l	15TW	6/14	3-20	240	3	1,100 N	5,000	SMCL	N	BSL

(1) Minimum/maximum detected concentration.

(2) Background: average of samples MW-1 collected 1/19/97 and 5/29/97, using one-half the SQL for non-detects.

(3) (Risk-based concentrations for tap waterl obtained from: "Risk-Based Concentration Table, " Roy L Smith, Ph.D., EPA Region III Senior Toxicologist. Obtained on-line 4/23/98. Units are ug/l.

(4) Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Background Levels (BKG)
Essential Nutrient (NUT)
Below Screening Level (BSL)

Definitions:
N/A = Not Applicable
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
MCL = Federal Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic

TABLE 3.1.1
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
ROSS METALS SITE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Process Area

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Antimony	mg/kg	182	217	730	J	mg/kg	217	95% UCL-T	Region IV Guidance	NA	NA	NA
Arsenic	mg/kg	50	99	479	J	mg/kg	99	95% UCL-T	Region IV Guidance	NA	NA	NA
Barium	mg/kg	111	157	790	J	mg/kg	157	95% UCL-T	Region IV Guidance	NA	NA	NA
Cadmium	mg/kg	15	130	99	J	mg/kg	99	Max	Region IV Guidance	NA	NA	NA
Copper	mg/kg	82	238	712	J	mg/kg	238	95% UCL-T	Region IV Guidance	NA	NA	NA
Lead	mg/kg	8,788	201,187	97,700	J	mg/kg	97,700	Max	Region IV Guidance	NA	NA	NA
Selenium	mg/kg	14	8	48	J	mg/kg	8	95% UCL-T	Region IV Guidance	NA	NA	NA

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

TABLE 3.1.2
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
ROSS METALS SITE

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Landfill Area

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Antimony	mg/kg	75	477	75	J	mg/kg	75	Max	Region IV Guidance	NA	NA	NA
Arsenic	mg/kg	33	406	76	J	mg/kg	76	Max	Region IV Guidance	NA	NA	NA
Cadmium	mg/kg	7	2,879	22	J	mg/kg	22	Max	Region IV Guidance	NA	NA	NA
Lead	mg/kg	5,964	211,223	42,400	J	mg/kg	42,400	Max	Region IV Guidance	NA	NA	NA
Manganese	mg/kg	615	1,466	1,100	J	mg/kg	1,100	Max	Region IV Guidance	NA	NA	NA

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

TABLE 3.1.3
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
ROSS METALS SITE

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Wetland/Woodland Area

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Aluminum	mg/kg	11,850	13,331	24,000	J	mg/kg	13,331	95% UCL-T	Region IV Guidance	NA	NA	NA
Antimony	mg/kg	126	32	1,350	J	mg/kg	32	95% UCL-T	Region IV Guidance	NA	NA	NA
Arsenic	mg/kg	40	41	681	J	mg/kg	41	95% UCL-T	Region IV Guidance	NA	NA	NA
Barium	mg/kg	131	147	610	J	mg/kg	147	95% UCL-T	Region IV Guidance	NA	NA	NA
Cadmium	mg/kg	5	6	18	J	mg/kg	6	95% UCL-T	Region IV Guidance	NA	NA	NA
Copper	mg/kg	40	43	465	J	mg/kg	43	95% UCL-T	Region IV Guidance	NA	NA	NA
Iron	mg/kg	16,706	19,576	40,000	J	mg/kg	19,576	95% UCL-T	Region IV Guidance	NA	NA	NA
Lead	mg/kg	4,555	5,827	98,100	J	mg/kg	5,827	95% UCL-T	Region IV Guidance	NA	NA	NA
Manganese	mg/kg	436	752	1,500	J	mg/kg	752	95% UCL-T	Region IV Guidance	NA	NA	NA
Selenium	mg/kg	10	4	84	J	mg/kg	4	95% UCL-T	Region IV Guidance	NA	NA	NA
Vanadium	mg/kg	28	31	63	J	mg/kg	31	95% UCL-T	Region IV Guidance	NA	NA	NA

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T);
Mean of Normal Data (Mean-N).

TABLE 3.1.4
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
ROSS METALS SITE

Scenario Timeframe: Current/Future
Medium: Surface water
Exposure Medium: Surface Water
Exposure Point: Wetland/Woodland Area

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Aluminum	ug/l	930	3,491,008	1,300		ug/l	1,300	Max	Region IV Guidance	NA	NA	NA
Antimony	ug/l	66	1,843	150		ug/l	150	Max	Region IV Guidance	NA	NA	NA
Arsenic	ug/l	109	7,941	554		ug/l	554	Max	Region IV Guidance	NA	NA	NA
Cadmium	ug/l	64	2,487	120		ug/l	120	Max	Region IV Guidance	NA	NA	NA
Copper	ug/l	47	1,452	140		ug/l	140	Max	Region IV Guidance	NA	NA	NA
Iron	ug/l	11,683	3.0E+11	42,700		ug/l	42,700	Max	Region IV Guidance	NA	NA	NA
Lead	ug/l	4,370	1.0E+10	16,000		ug/l	16,000	Max	Region IV Guidance	NA	NA	NA
Manganese	ug/l	1,970	2.0E+08	5,520		ug/l	5,520	Max	Region IV Guidance	NA	NA	NA
Mercury	ug/l	0.3	1	0.4	J	ug/l	0.4	Max	Region IV Guidance	NA	NA	NA
Selenium	ug/l	9	7	11		ug/l	7	95% UCL-T	Region IV Guidance	NA	NA	NA
Thallium	ug/l	13	15	13		ug/l	13	95% UCL-T	Region IV Guidance	NA	NA	NA
Zinc	ug/l	200	25,312	568		ug/l	568	95% UCL-T	Region IV Guidance	NA	NA	NA

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

TABLE 3.1.5
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
ROSS METALS SITE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Process Area

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Aluminum	ug/l	2,608	NA	23,000	J	ug/l	2,608	Mean-N	Region IV Guidance	NA	NA	NA
Arsenic	ug/l	20	NA	40	J	ug/l	20	Mean-N	Region IV Guidance	NA	NA	NA
Barium	ug/l	90	NA	380	J	ug/l	90	Mean-N	Region IV Guidance	NA	NA	NA
Cadmium	ug/l	2	NA	7	J	ug/l	2	Mean-N	Region IV Guidance	NA	NA	NA
Chromium	ug/l	6	NA	39	J	ug/l	6	Mean-N	Region IV Guidance	NA	NA	NA
Iron	ug/l	12,126	NA	64,000	J	ug/l	12,126	Mean-N	Region IV Guidance	NA	NA	NA
Lead	ug/l	196	NA	1,600	J	ug/l	196	Mean-N	Region IV Guidance	NA	NA	NA
Manganese	ug/l	1,472	NA	5,600	J	ug/l	1,472	Mean-N	Region IV Guidance	NA	NA	NA
Nickel	ug/l	24	NA	160	J	ug/l	24	Mean-N	Region IV Guidance	NA	NA	NA
Vanadium	ug/l	6	NA	49	J	ug/l	6	Mean-N	Region IV Guidance	NA	NA	NA

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

TABLE 4.1.1

VALUES USED FOR DAILY INTAKE CALCULATIONS

ROSS METALS SITE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Process Area
Receptor Population: Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	chemical concentration in water (ug/L)	ug/l	See Table 3	See Table 3	--	--	Chronic daily intake (mg/kg-day) = CW x IR x EF x ED x CF1 x 1/BW x 1/AT
	IR-W	ingestion rate (L/d)	liters/day	1	EPA 1991	--	--	
	EF	exposure frequency (d/yr)	days/year	250	EPA 1991	--	--	
	ED	exposure duration (yr)	years	25	EPA 1991	--	--	
	CF1	conversion factor (mg/ug)	mg/ug	0.001	EPA 1991	--	--	
	BW	body weight (kg)	kg	70	EPA 1991	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	9,125	EPA 1989	--	--	

U.S. EPA. 1989. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part A) December. Appendix A.

U.S. EPA. 1991. Human Health Evaluation Manual, Supplemental Guidance: "StandardDefault Exposure Factors," OSWER Directive 9298.6-03, March 25.

TABLE 4.1.2

VALUES USED FOR DAILY INTAKE CALCULATIONS

ROSS METALS SITE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Process Area
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	chemical concentration in water (ug/L)	ug/l	See Table 3	See Table 3	--	--	Chronic daily intake (mg/kg-day) = CW x IR x EF x ED x CF1 x 1/BW x 1/AT
	IR-W	ingestion rate (L/d)	liters/day	1	EPA 1991	--	--	
	EF	exposure frequency (d/yr)	days/year	350	EPA 1991	--	--	
	ED	exposure duration (yr)	years	6	EPA 1991	--	--	
	CF1	conversion factor (mg/ug)	mg/ug	0.001	EPA 1991	--	--	
	BW	body weight (kg)	kg	15	EPA 1991	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	2,190	EPA 1989	--	--	

U.S. EPA. 1989. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part A) December. Appendix A.

U.S. EPA. 1991. Human Health Evaluation Manual, Supplemental Guidance: "StandardDefault Exposure Factors," OSWER Directive 9298.6-03, March 25.

TABLE 4.1.3

VALUES USED FOR DAILY INTAKE CALCULATIONS

ROSS METALS SITE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Process Area
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	chemical concentration in water (ug/L)	ug/l	See Table 3	See Table 3	--	--	Chronic daily intake (mg/kg-day) = CW x IR x EF x ED x CF1 x 1/BW x 1/AT
	IR-W	ingestion rate (L/d)	liters/day	2	EPA 1991	--	--	
	EF	exposure frequency (d/yr)	days/year	350	EPA 1991	--	--	
	ED	exposure duration (yr)	years	24	EPA 1991	--	--	
	CF1	conversion factor (mg/ug)	mg/ug	0.001	EPA 1991	--	--	
	BW	body weight (kg)	kg	70	EPA 1991	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	8,760	EPA 1989	--	--	

U.S. EPA. 1989. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part A) December. Appendix A.

U.S. EPA. 1991. Human Health Evaluation Manual, Supplemental Guidance: "StandardDefault Exposure Factors," OSWER Directive 9298.6-03, March 25.

TABLE 4.1.4

VALUES USED FOR DAILY INTAKE CALCULATIONS

ROSS METALS SITE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Process Area
Receptor Population: Resident
Receptor Age: Lifetime resident

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	chemical concentration in water	ug/l	See Table 3	See Table 3	--	--	Chronic daily intake (mg/kg-day) = CW x IF-W x EF x CF1 x 1/AT
	IF-W	ingestion factor	liters-yr/kg-day	1.09	EPA 1991	--	--	
	EF	exposure frequency	days/year	365	EPA 1991	--	--	
	CF1	conversion factor	mg/ug	0.001	EPA 1991	--	--	
	AT-N	averaging time (non-cancer)	days	10,950	EPA 1991	--	--	

U.S. EPA. 1991. Human Health Evaluation Manual, Part B: Development of Risk-Based Preliminary Remediation Goals," OSWER Directive 9285.7-01B, December 13.

TABLE 4.2.1

VALUES USED FOR DAILY INTAKE CALCULATIONS

ROSS METALS SITE

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Process Area
Receptor Population: Trespasser/visitor
Receptor Age: Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	Chronic daily intake (CDI) = CS x IR x CF x FI x EF x ED x 1/BW x 1/AT
	IR-S	ingestion rate	mg/day	100	Judgment	--	--	
	EF	exposure frequency	days/year	50	Judgment	--	--	
	ED	exposure duration	years	10	Judgment	--	--	
	CF3	conversion factor	kg/mg	0.000001	--	--	--	
	BW	body weight	kg	45	EPA 1995	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	3,650	EPA 1989	--	--	
Dermal	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	CDI = CS x CF x SA x AF x ABS x EF x ED x 1/BW x 1/AT
	SA	Surface area	cm^2	5800	EPA 1997	--	--	
	AF	Adherence factor	mg/cm^2	1	EPA 1995			
	EF	exposure frequency	days/year	50	Judgment	--	--	
	ED	exposure duration	years	10	Judgment	--	--	
	CF3	conversion factor	kg/mg	0.000001	--	--	--	
	BW	body weight	kg	45	EPA 1995	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	3,650	EPA 1989	--	--	
Inhalation	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	CDI = CS x IN x ED x EF x (1/PEF) x 1/BW x 1/AT
	IN	Inhalation rate	m3/day	17	EPA 1997	--	--	
	PEF	particulate emissions factor	m3/kg	1.32E+09	EPA 1991a	--	--	
	EF	exposure frequency	days/year	50	Judgment	--	--	
	ED	exposure duration	years	10	Judgment	--	--	
	BW	body weight	kg	45	EPA 1995	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	3,650	EPA 1989	--	--	

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TABLE 4.2.2

VALUES USED FOR DAILY INTAKE CALCULATIONS

ROSS METALS SITE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Process Area
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	Chronic daily intake (CDI) = CS x IR x CF x FI x EF x ED x 1/BW x 1/AT
	IR-S	ingestion rate	mg/day	200	EPA 1991a	--	--	
	EF	exposure frequency	days/year	350	EPA 1991a	--	--	
	ED	exposure duration	years	6	EPA 1991a	--	--	
	CF3	conversion factor	kg/mg	0.000001	--	--	--	
	BW	body weight	kg	15	EPA 1991a	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	2,190	EPA 1989	--	--	
Dermal	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	CDI = CS x CF x SA x AF x ABS x EF x ED x 1/BW x 1/AT
	SA	Surface area	cm^2	2,650	EPA 1997	--	--	
	AF	Adherence factor	mg/cm^2	1	EPA 1995			
	EF	exposure frequency	days/year	350	EPA 1991a	--	--	
	ED	exposure duration	years	6	EPA 1991a	--	--	
	CF3	conversion factor	kg/mg	0.000001	--	--	--	
	BW	body weight	kg	15	EPA 1991a	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	2,190	EPA 1989	--	--	
Inhalation	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	CDI = CS x IN x ED x EF x (1/PEF) x 1/BW x 1/AT
	IN	Inhalation rate	m3/day	10	EPA 1991a	--	--	
	PEF	particulate emissions factor	m3/kg	1.32E+09	EPA 1991b	--	--	
	EF	exposure frequency	days/year	350	EPA 1991a	--	--	
	ED	exposure duration	years	6	EPA 1991a	--	--	
	BW	body weight	kg	15	EPA 1991a	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	2,190	EPA 1989	--	--	

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TABLE 4.2.3

VALUES USED FOR DAILY INTAKE CALCULATIONS

ROSS METALS SITE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Process Area
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	Chronic daily intake (CDI) = CS x IR x CF x FI x EF x ED x 1/BW x 1/AT
	IR-S	ingestion rate	mg/day	100	EPA 1991a	--	--	
	EF	exposure frequency	days/year	350	EPA 1991a	--	--	
	ED	exposure duration	years	24	EPA 1991a	--	--	
	CF3	conversion factor	kg/mg	0.000001	--	--	--	
	BW	body weight	kg	70	EPA 1991a	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	8,760	EPA 1989	--	--	
Dermal	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	CDI = CS x CF x SA x AF x ABS x EF x ED x 1/BW x 1/AT
	SA	Surface area	cm^2	5800	EPA 1997	--	--	
	AF	Adherence factor	mg/cm^2	1	EPA 1995			
	EF	exposure frequency	days/year	350	EPA 1991a	--	--	
	ED	exposure duration	years	24	EPA 1991a	--	--	
	CF3	conversion factor	kg/mg	0.000001	--	--	--	
	BW	body weight	kg	70	EPA 1991a	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	8,760	EPA 1989	--	--	
Inhalation	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	CDI = CS x IN x ED x EF x (1/PEF) x 1/BW x 1/AT
	IN	Inhalation rate	m3/day	20	EPA 1991a	--	--	
	PEF	particulate emissions factor	m3/kg	1.32E+09	EPA 1991b	--	--	
	EF	exposure frequency	days/year	350	EPA 1991a	--	--	
	ED	exposure duration	years	24	EPA 1991a	--	--	
	BW	body weight	kg	70	EPA 1991a	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	8,760	EPA 1989	--	--	

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TABLE 4.2.4

VALUES USED FOR DAILY INTAKE CALCULATIONS

ROSS METALS SITE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Process Area
Receptor Population: Lifetime resident
Receptor Age: Lifetime resident

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	Chronic daily intake (mg/kg-day) = CS x IF-S x EF x CF2 x 1/AT
	IF-S	ingestion factor	mg-yr/kg-day	114	EPA 1991	--	--	
	EF	exposure frequency	days/year	365	EPA 1991	--	--	
	CF2	conversion factor	kg/mg	0.000001	EPA 1991	--	--	
	AT-N	averaging time (non-cancer)	days	10,950	EPA 1991	--	--	
Dermal	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	Chronic daily intake (mg/kg-day) = CS x DF x AF x ABS x EF x CF2 x 1/AT
	DF	dermal factor	cm^2-yr/kg-day	3,049	EPA 1991	--	--	
	AF	adherence factor	1	mg/cm^2	EPA 1995	--	--	
	ABS	absorption factor	0.001	--	EPA 1995	--	--	
	EF	exposure frequency	days/year	365	EPA 1991	--	--	
	CF2	conversion factor	kg/mg	0.000001	EPA 1991	--	--	
	AT-N	averaging time (non-cancer)	days	10,950	EPA 1991	--	--	
Inhalation	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	Chronic daily intake (mg/kg-day) = CS x IF x PEF x EF x 1/AT
	IF	inhalation factor	m3-yr/kg-day	10.9	EPA 1991	--	--	
	EF	exposure frequency	days/year	365	EPA 1991	--	--	
	PEF	particulate emissions factor	m^3/kg	1.32E+09	EPA 1991	--	--	
	AT-N	averaging time (non-cancer)	days	10,950	EPA 1991	--	--	

U.S. EPA. 1991. Human Health Evaluation Manual, Part B: Development of Risk-Based Preliminary Remediation Goals," OSWER Directive 9285.7-01B, December 13.

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TABLE 4.3.1

VALUES USED FOR DAILY INTAKE CALCULATIONS

ROSS METALS SITE

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Landfill Area
Receptor Population: Trespasser/visitor
Receptor Age: Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	Chronic daily intake (CDI) = CS x IR x CF x FI x EF x ED x 1/BW x 1/AT
	IR-S	ingestion rate	mg/day	100	Judgment	--	--	
	EF	exposure frequency	days/year	50	Judgment	--	--	
	ED	exposure duration	years	10	Judgment	--	--	
	CF3	conversion factor	kg/mg	0.000001	--	--	--	
	BW	body weight	kg	45	EPA 1995	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	3,650	EPA 1989	--	--	
Dermal	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	CDI = CS x CF x SA x AF x ABS x EF x ED x 1/BW x 1/AT
	SA	Surface area	cm^2	5800	EPA 1997	--	--	
	AF	Adherence factor	mg/cm^2	1	EPA 1995			
	EF	exposure frequency	days/year	50	Judgment	--	--	
	ED	exposure duration	years	10	Judgment	--	--	
	CF3	conversion factor	kg/mg	0.000001	--	--	--	
	BW	body weight	kg	45	EPA 1995	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	3,650	EPA 1989	--	--	
Inhalation	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	CDI = CS x IN x ED x EF x (1/PEF) x 1/BW x 1/AT
	IN	Inhalation rate	m3/day	17	EPA 1997	--	--	
	PEF	particulate emissions factor	m3/kg	1.32E+09	EPA 1991a	--	--	
	EF	exposure frequency	days/year	50	Judgment	--	--	
	ED	exposure duration	years	10	Judgment	--	--	
	BW	body weight	kg	45	EPA 1995	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	3,650	EPA 1989	--	--	

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TABLE 4.3.2

VALUES USED FOR DAILY INTAKE CALCULATIONS

ROSS METALS SITE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Landfill Area
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	Chronic daily intake (CDI) = CS x IR x CF x FI x EF x ED x 1/BW x 1/AT
	IR-S	ingestion rate	mg/day	200	EPA 1991a	--	--	
	EF	exposure frequency	days/year	350	EPA 1991a	--	--	
	ED	exposure duration	years	6	EPA 1991a	--	--	
	CF3	conversion factor	kg/mg	0.000001	--	--	--	
	BW	body weight	kg	15	EPA 1991a	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	2,190	EPA 1989	--	--	
Dermal	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	CDI = CS x CF x SA x AF x ABS x EF x ED x 1/BW x 1/AT
	SA	Surface area	cm^2	2,650	EPA 1997	--	--	
	AF	Adherence factor	mg/cm^2	1	EPA 1995			
	EF	exposure frequency	days/year	350	EPA 1991a	--	--	
	ED	exposure duration	years	6	EPA 1991a	--	--	
	CF3	conversion factor	kg/mg	0.000001	--	--	--	
	BW	body weight	kg	15	EPA 1991a	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	2,190	EPA 1989	--	--	
Inhalation	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	CDI = CS x IN x ED x EF x (1/PEF) x 1/BW x 1/AT
	IN	Inhalation rate	m3/day	10	EPA 1991a	--	--	
	PEF	particulate emissions factor	m3/kg	1.32E+09	EPA 1991b	--	--	
	EF	exposure frequency	days/year	350	EPA 1991a	--	--	
	ED	exposure duration	years	6	EPA 1991a	--	--	
	BW	body weight	kg	15	EPA 1991a	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	2,190	EPA 1989	--	--	

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TABLE 4.3.3

VALUES USED FOR DAILY INTAKE CALCULATIONS

ROSS METALS SITE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Landfill Area
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	Chronic daily intake (CDI) = CS x IR x CF x FI x EF x ED x 1/BW x 1/AT
	IR-S	ingestion rate	mg/day	100	EPA 1991a	--	--	
	EF	exposure frequency	days/year	350	EPA 1991a	--	--	
	ED	exposure duration	years	24	EPA 1991a	--	--	
	CF3	conversion factor	kg/mg	0.000001	--	--	--	
	BW	body weight	kg	70	EPA 1991a	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	8,760	EPA 1989	--	--	
Dermal	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	CDI = CS x CF x SA x AF x ABS x EF x ED x 1/BW x 1/AT
	SA	Surface area	cm^2	5800	EPA 1997	--	--	
	AF	Adherence factor	mg/cm^2	1	EPA 1995			
	EF	exposure frequency	days/year	350	EPA 1991a	--	--	
	ED	exposure duration	years	24	EPA 1991a	--	--	
	CF3	conversion factor	kg/mg	0.000001	--	--	--	
	BW	body weight	kg	70	EPA 1991a	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	8,760	EPA 1989	--	--	
Inhalation	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	CDI = CS x IN x ED x EF x (1/PEF) x 1/BW x 1/AT
	IN	Inhalation rate	m3/day	20	EPA 1991a	--	--	
	PEF	particulate emissions factor	m3/kg	1.32E+09	EPA 1991b	--	--	
	EF	exposure frequency	days/year	350	EPA 1991a	--	--	
	ED	exposure duration	years	24	EPA 1991a	--	--	
	BW	body weight	kg	70	EPA 1991a	--	--	
	AT-C	averaging time (cancer)	days	25,550	EPA 1989	--	--	
	AT-N	averaging time (non-cancer)	days	8,760	EPA 1989	--	--	

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U.S. EPA. 1991a. Human Health Evaluation Manual, Supplemental Guidance: "StandardDefault Exposure Factors," OSWER Directive 9298.6-03, March 25.

U.S. EPA. 1991b. Human Health Evaluation Manual, Part B: Development of Risk-Based Preliminary Remediation Goals," OSWER Directive 9285.7-01B, December 13.

U.S. EPA. 1995. "Supplemental Guidance to RAGS: Region 4 Bulletins. Human Health Risk Assessment." November.

U.S. EPA. 1997. Exposure Factors Handbook, Volume 1, General Factors. Prepared by the Office of Research and Development. August.

TABLE 4.3.4

VALUES USED FOR DAILY INTAKE CALCULATIONS

ROSS METALS SITE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil
Exposure Point: Landfill Area
Receptor Population: Lifetime resident
Receptor Age: Lifetime resident

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	Chronic daily intake (mg/kg-day) = CS x IF-S x EF x CF2 x 1/AT
	IF-S	ingestion factor	mg-yr/kg-day	114	EPA 1991	--	--	
	EF	exposure frequency	days/year	365	EPA 1991	--	--	
	CF2	conversion factor	kg/mg	0.000001	EPA 1991	--	--	
	AT-N	averaging time (non-cancer)	days	10,950	EPA 1991	--	--	
Dermal	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	Chronic daily intake (mg/kg-day) = CS x DF x AF x ABS x EF x CF2 x 1/AT
	DF	dermal factor	cm^2-yr/kg-day	3,049	EPA 1991	--	--	
	AF	adherence factor	1	mg/cm^2	EPA 1995	--	--	
	ABS	absorption factor	0.001	--	EPA 1995	--	--	
	EF	exposure frequency	days/year	365	EPA 1991	--	--	
	CF2	conversion factor	kg/mg	0.000001	EPA 1991	--	--	
	AT-N	averaging time (non-cancer)	days	10,950	EPA 1991	--	--	
Inhalation	CS	chemical concentration in soil	mg/kg	See Table 3	See Table 3	--	--	Chronic daily intake (mg/kg-day) = CS x IF x PEF x EF x 1/AT
	IF	inhalation factor	m3-yr/kg-day	10.9	EPA 1991	--	--	
	EF	exposure frequency	days/year	365	EPA 1991	--	--	
	PEF	particulate emissions factor	m^3/kg	1.32E+09	EPA 1991	--	--	
	AT-N	averaging time (non-cancer)	days	10,950	EPA 1991	--	--	

U.S. EPA. 1991. Human Health Evaluation Manual, Part B: Development of Risk-Based Preliminary Remediation Goals," OSWER Directive 9285.7-01B, December 13.

U.S. EPA. 1995. "Supplemental Guidance to RAGS: Region 4 Bulletins. Human Health Risk Assessment." November.

TABLE 5.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

ROSS METALS SITE

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Dermal RfD Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD Target Organ
Aluminum	Chronic	1E+00	mg/kg/day	20%	2E-01	mg/kg/day	Not specified	NA	NCEA	04/23/98
Antimony	Chronic	4E-04	mg/kg/day	20%	8E-05	mg/kg/day	Longevity, blood glucose	1000	IRIS	04/23/98
Arsenic	Chronic	3E-04	mg/kg/day	100%	3E-04	mg/kg/day	Hyperpigmentation	3	IRIS	04/23/98
Barium	Chronic	7E-02	mg/kg/day	20%	1E-02	mg/kg/day	Increased blood pressure	3	IRIS	04/23/98
Cadmium (water)	Chronic	5E-04	mg/kg/day	20%	1E-04	mg/kg/day	Proteinuria	10	IRIS	04/23/98
Cadmium (food)	Chronic	1E-03	mg/kg/day	20%	2E-04	mg/kg/day	Proteinuria	10	IRIS	04/23/98
Chromium	Chronic	5E-03	mg/kg/day	20%	1E-03	mg/kg/day	NOAEL	500	IRIS	04/23/98
Copper	Chronic	4E-02	mg/kg/day	20%	8E-03	mg/kg/day	Not specified	NA	NCEA	04/23/98
Iron	Chronic	3E-01	mg/kg/day	20%	6E-02	mg/kg/day	NOAEL	NA	NCEA	04/23/98
Lead	Chronic	NA	mg/kg/day	20%	NA	mg/kg/day	CNS effects, blood	NA	NA	NA
Manganese (water)	Chronic	2.4E-02	mg/kg/day	20%	5E-03	mg/kg/day	Neurotoxicity	1	IRIS	04/23/98
Manganese (soil)	Chronic	7E-02	mg/kg/day	20%	1E-02	mg/kg/day	NOAEL	1	IRIS	1995
Mercury	Chronic	3E-04	mg/kg/day	20%	6E-05	mg/kg/day	Neurotoxicity	30	HEAST	1995
Nickel	Chronic	2E-02	mg/kg/day	20%	4E-03	mg/kg/day	Decreased body, organ weights	300	IRIS	04/23/98
Selenium	Chronic	5E-03	mg/kg/day	20%	1E-03	mg/kg/day	Clinical selenosis	3	IRIS	04/23/98
Thallium	Chronic	9E-05	mg/kg/day	20%	2E-05	mg/kg/day	Increased SGOT and LDH	3000	IRIS	04/23/98
Vanadium	Chronic	7E-03	mg/kg/day	20%	1E-03	mg/kg/day	Decreased hair cystine	100	IRIS	04/23/98
Zinc	Chronic	3E-01	mg/kg/day	20%	6E-02	mg/kg/day	Decreased ESOD	3	IRIS	04/23/98

N/A = Not Applicable

(1) EPA 1989. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part A) December. Appendix A.

(2) Equation used for derivation: RfD x oral to dermal adjustment factor

TABLE 5.2

NON-CANCER TOXICITY DATA -- INHALATION

ROSS METALS SITE

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC Value	RfC Units	Adjusted Inhalation RfD (1)	Inhalation RfD Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfC: Target Organ	Dates of RfC Target Organ
Manganese	Chronic	5E-05	mg/m^3	1.43E-05	mg/kg/day	Neurotoxicity	1000	IRIS	4/23/98

N/A = Not Applicable

(1) Equation used for derivation: RfC divided by 70 kg (assumed human body weight) multiplied by 20 m3/day (assumed human intake rate)

TABLE 6.1

CANCER TOXICITY DATA -- ORAL/DERMAL

ROSS METALS SITE

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal CSF (2)	Dermal CSF Units	Weight of Evidence/ Cancer Guideline Description	Sources of CSF: Target Organ	Dates of CSF Target Organ
Aluminum	NA	20%	NA	NA	D	NA	NA
Antimony	NA	20%	NA	NA	D	NA	NA
Arsenic	1.5E+00	100%	1.5E+00	$(mg/kg/day)^{-1}$	A	IRIS	04/23/98
Barium	NA	20%	NA	NA	D	NA	NA
Cadmium	NA	20%	NA	NA	D	NA	NA
Chromium	NA	20%	NA	NA	D	NA	NA
Copper	NA	20%	NA	NA	D	NA	NA
Iron	NA	20%	NA	NA	D	NA	NA
Lead	NA	20%	NA	NA	D	NA	NA
Manganese	NA	20%	NA	NA	D	NA	NA
Mercury	NA	20%	NA	NA	D	NA	NA
Nickel	NA	20%	NA	NA	D	NA	NA
Selenium	NA	20%	NA	NA	D	NA	NA
Thallium	NA	20%	NA	NA	D	NA	NA
Vanadium	NA	20%	NA	NA	D	NA	NA
Zinc	NA	20%	NA	NA	D	NA	NA

(1) EPA 1989. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part A) December. Appendix A.

(2) Equation used for derivation: CSF divided by oral to dermal adjustment factor

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

Weight of Evidence:

Known/Likely

TABLE 6.2

CANCER TOXICITY DATA -- INHALATION

ROSS METALS SITE

Chemical of Potential Concern	Unit Risk	Units	Adjustment (1)	Inhalation Cancer Slope Factor	Inhalation CSF Units	Weight of Evidence/ Cancer Guideline Description	Sources of CSF: Target Organ	Dates of CSF Target Organ
Arsenic	4.30E-03	ug/m^3	3500	NA [2]	$(mg/kg/day)^{-1}$	A	IRIS	4/23/98
Cadmium	1.80E-03	ug/m^3	3500	6.30E+00	$(mg/kg/day)^{-1}$	B1	IRIS	4/23/98
Chromium	1.20E-02	ug/m^3	3500	4.20E+01	$(mg/kg/day)^{-1}$	A	IRIS	4/23/98

(1) Adjustment: 70 kg (assumed human body weight) divided by 20 m3/day (assumed human intake rate) multiplied by 1000 ug/mg (conversion factor)

(2) Region 4 EPA policy is to evaluate exposure to arsenic in soil as a noncarcinogen; therefore, calculation of a slope factor is not applicable.

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

Weight of Evidence:

Known/Likely

Cannot be Determined

Alternative 1 (Soils)-- No Action

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Ross Metals
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
No Action (5-Year Review)				$0
Subtotal - Capital Cost				$0
Engineering & Administrative (3% of Capital Cost)				$0
Subtotal				$0
Contingency (10% of Subtotal)				$0
TOTAL CONSTRUCTION COST				$0
PRESENT WORTH O&M COST				$100,247
TOTAL PRESENT WORTH COST				$100,247

Alternative 1 (Soils)-- No Action

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Ross Metals
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
5-YEAR REVIEWS						
Personnel (2-man crew @ 4 12-hour days)	hours	96	$50	$960	30	$11,913
Supplies/ Travel	days	5	$3,000	$3,000	30	$37,227
Soil/Sediment/Wipe Sampling and Lab Testing	sample	30	$500	$3,000	30	$37,227
Report Preparation	lump sum	1	$5,000	$1,000	6	$4,767
O&M SUBTOTAL				$7,960		$91,133
Contractor Fee (10% of O&M cost)				$796		$9,113
Legal Fees, Licenses & Permits (5% of O&M Cost)				$40		$456
CONTINGENCY (10% of Subtotal)				$1,990		$9,113
SUBTOTAL				$9,950		$100,247

Alternative 1 (Wetland Sediment)-- No Action

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Ross Metals
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
No Action (5-Year Review)				$0
Subtotal - Capital Cost				$0
Engineering & Administrative (3% of Capital Cost)				$0
Subtotal				$0
Contingency (10% of Subtotal)				$0
TOTAL CONSTRUCTION COST				$0
PRESENT WORTH O&M COST				$100,247
TOTAL PRESENT WORTH COST				$100,247

Alternative 1 (Wetland Sediment)-- No Action

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Ross Metals
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
5-YEAR REVIEWS						
Personnel (2-man crew @ 4 12-hour days)	hours	96	$50	$960	30	$11,913
Supplies/ Travel	days	5	$3,000	$3,000	30	$37,227
Soil/Sediment/Wipe Sampling and Lab Testing	sample	30	$500	$3,000	30	$37,227
Report Preparation	lump sum	1	$5,000	$1,000	6	$4,767
O&M SUBTOTAL				$7,960		$91,133
Contractor Fee (10% of O&M cost)				$796		$9,113
Legal Fees, Licenses & Permits (5% of O&M Cost)				$40		$456
CONTINGENCY (10% of Subtotal)				$1,990		$9,113
SUBTOTAL				$9,950		$100,247

Alternative 1 (Groundwater)-- No Action

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Ross Metals
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
No Action (5-Year Review)				$0
Subtotal - Capital Cost				$0
Engineering & Administrative (3% of Capital Cost)				$0
Subtotal				$0
Contingency (10% of Subtotal)				$0
TOTAL CONSTRUCTION COST				$0
PRESENT WORTH O&M COST				$86,597
TOTAL PRESENT WORTH COST				$86,597

Alternative 1 (Groundwater)-- No Action

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Ross Metals
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
5-YEAR REVIEWS						
Personnel (2-man crew @ 4 12-hour days)	hours	96	$50	$960	30	$11,913
Supplies/ Travel	days	5	$3,000	$3,000	30	$37,227
Groundwater Sampling and Lab Testing	sample	20	$500	$2,000	30	$24,818
Report Preparation	lump sum	1	$5,000	$1,000	6	$4,767
O&M SUBTOTAL				$6,960		$78,724
Contractor Fee (10% of O&M cost)				$696		$7,872
Legal Fees, Licenses & Permits (5% of O&M Cost)				$35		$394
CONTINGENCY (10% of Subtotal)				$1,740		$7,872
SUBTOTAL				$8,700		$86,597

Alternative 2 (Soil)-- Capping
Option 2 (without wetland sediment)

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION				
	each	1	$80,000	$80,000
SITE DEMOLITION				
Building Demolition	cf	27,000	$0.23	$6,210
Concrete/Asphalt Demolition	sy	21,333	$10.37	$221,223
EXCAVATION				
Soil Excavation (Contaminated Soil)	cy	15,625	$5	$78,125
Soil Excavation (Onsite Disposal Area)	cy	36,200	$5	$181,000
Dust Control	month	8	$3,500	$28,000
Excavation Monitoring	sample	20	$500	$10,000
CAPPING				
Spread/Compact Waste Soil and Debris	cy	26,325	$2.22	$58,442
Installation of Soil Cushion	cy	20,300	$2.22	$45,066
Installation of Geomembrane/Geotextile	sf	291,852	$1	$291,852
Installation of Common Fill Throughout Site (from disposal ex	cy	15,900	$2.22	$35,298
Installation of Top Soil Throughout Site	cy	6,500	$19.90	$129,350
Installation of Vegetative Cover	acre	8	$2,000.00	$16,000
Runon/Runoff Control-Trenching	ft	2,500	$0.78	$1,950
Runon/Runoff Control-Sediment Trap	lump sum	1	$35,000.00	$35,000
EQUIPMENT & MATERIALS				
Erosion Control	sy	341	$2.14	$730
Fencing (Remove and Reset)	lf	2,100	$15	$32,025
Health & Safety Equipment	each	1	$120,000	$120,000
Subtotal - Capital Cost				$1,370,270
Engineering & Administrative (3% of Capital Cost)				$41,108
Subtotal				$1,411,379
Contingency (10% of Subtotal)				$141,138
TOTAL CONSTRUCTION COST				$1,552,516
PRESENT WORTH O&M COST				$159,895
TOTAL PRESENT WORTH COST				$1,712,412

Alternative 2 (Soil)-- Capping
Option 2 (without wetland sediment)

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
CAP INSPECTION	inspection	2	$2,000	$4,000	30	$49,636
CAP MAINTENANCE	sf	2900	$2.66	$7,714	30	$95,723
SUBTOTAL				$11,714		$145,360
CONTINGENCY (10% of Subtotal)				$2,929		$14,536
TOTAL				$14,643		$159,895

Alternative 2 (Wetland Sediment)-- Capping

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION	each	1	$50,000	$50,000
CAPPING				
Installation of Top Soil Throughout Site (1 ft layer)	cy	9,300	$19.90	$185,070
Installation of Vegetative Cover	acre	6	$2,000.00	$11,400
Runon/Runoff Control-Trenching	ft	2,800	$0.78	$2,184
Runon/Runoff Control-Sediment Trap	lump sum	1	$35,000.00	$35,000
OFF-SITE CREATION OF WETLANDS				
Land Preparation	acre	9	$1,000.00	$9,000
Plant Forested Wetland Area	acre	3	$3,500.00	$10,500
Plant Emergent Wetland Area	acre	9	$5,500.00	$49,500
Supplies	lump sum	1	$1,600.00	$1,600
EQUIPMENT & MATERIALS				
Erosion Control	sy	500	$2.14	$1,070
Fencing	lf	2,800	$15	$42,700
Health & Safety Equipment	each	1	$80,000	$80,000
Subtotal - Capital Cost				$478,024
Engineering & Administrative (3% of Capital Cost)				$14,341
Subtotal				$492,365
Contingency (10% of Subtotal)				$49,236
TOTAL CONSTRUCTION COST				$541,601
PRESENT WORTH O&M COST				$70,161
TOTAL PRESENT WORTH COST				$611,762

NOTE: Alternative assumes no acquistion cost for land to be used for wetlands creation.

Alternative 2 (Wetland Sediment)-- Capping

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
CAP INSPECTION	inspection	2	$2,000	$4,000	30	$49,636
CAP MAINTENANCE	acre	5.7	$200.00	$1,140	30	$14,146
SUBTOTAL				$5,140		$63,782
CONTINGENCY (10% of Subtotal)				$1,285		$6,378
TOTAL				$6,425		$70,161

Alternative 2 (Groundwater)-- Limited Action Site Name: Ross Metals Site Location: Rossville, Tennessee			PRESENT WORTH COST Discount Rate: 7%	
ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
ADDITIONAL DATA COLLECTION				
Pump Test (Existing Wells)	lump sum	1	$25,000.00	$25,000
Determine Vertical Extent of GW Contamination	lump sum	1	$20,000.00	$20,000
CONTINGENCY PLAN DEVELOPMENT	lump sum	1	$50,000.00	$50,000
(Development of contingency Pump &Treat)				
TREATABILITY STUDY	lump sum	1	$20,000.00	$20,000
Subtotal - Capital Cost				$115,000
Engineering & Administrative (3% of Capital Cost)				$3,450
Subtotal				$118,450
Contingency (10% of Subtotal)				$11,845
TOTAL CONSTRUCTION COST				$130,295
PRESENT WORTH O&M COST				$367,800
TOTAL PRESENT WORTH COST				$498,095

Alternative 2 (Groundwater)-- Limited Action Site Name: Ross Metals Site Location: Rossville, Tennessee				OPERATION & MAINTENANCE COSTS Discount Rate: 7%		
ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
QUARTERLY GROUNDWATER MONITORING						
Personnel (2-man crew @ 4 12-hour days)	hours	384	$50	$19,200	2	$34,714
Supplies/ Travel	days	20	$3,000	$60,000	2	$108,481
Groundwater Sampling and Lab Testing	sample	40	$500	$20,000	2	$36,160
Report Preparation	lump sum	4	$5,000	$20,000	2	$36,160
5-YEAR REVIEWS						
Personnel (2-man crew @ 4 12-hour days)	hours	96	$50	$960	30	$11,913
Supplies/ Travel	days	5	$3,000	$3,000	30	$37,227
Groundwater Sampling and Lab Testing	sample	20	$500	$2,000	30	$24,818
Report Preparation	lump sum	1	$5,000	$1,000	6	$4,767
O&M SUBTOTAL				$126,160		$294,240
Contractor Fee (10% of O&M cost)				$12,616		$29,424
Legal Fees, Licenses & Permits (5% of O&M Cost)				$631		$1,471
CONTINGENCY (25% of Subtotal)				$31,540		$73,560
SUBTOTAL				$157,700		$367,800

Alternative 3 (Soil)-- Capping With Pavement in Place
Option 2 (without wetlands sediment)

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION				
	each	1	$50,000	$50,000
SITE DEMOLITION				
Building Demolition	cf	27,000	$0.23	$6,210
EXCAVATION				
Soil Excavation (Contaminated Soil)	cy	3,800	$5	$19,000
Dust Control	month	8	$3,500	$28,000
Excavation Monitoring	sample	10	$500	$5,000
CAPPING				
Spread/Compact Waste Soil and Debris	cy	9,800	$2.22	$21,756
Installation of Soil Cushion	cy	20,300	$10.00	$203,000
Installation of Geomembrane/Geotextile	sf	291,852	$1	$291,852
Installation of Common Fill Throughout Site (from disposal e	cy	16,150	$10.00	$161,500
Installation of Top Soil Throughout Site	cy	6,500	$19.90	$129,350
Installation of Vegetative Cover	acre	8	$2,000.00	$16,000
Runon/Runoff Control-Trenching	ft	2,500	$0.78	$1,950
Runon/Runoff Control-Sediment Trap	lump sum	1	$35,000.00	$35,000
EQUIPMENT & MATERIALS				
Erosion Control	sy	341	$2.14	$730
Fencing (Remove and Reset)	lf	2,100	$15	$32,025
Health & Safety Equipment	each	1	$120,000	$120,000
Subtotal - Capital Cost				$1,121,373
Engineering & Administrative (3% of Capital Cost)				$33,641
Subtotal				$1,155,014
Contingency (10% of Subtotal)				$115,501
TOTAL CONSTRUCTION COST				$1,270,515
PRESENT WORTH O&M COST				$159,895
TOTAL PRESENT WORTH COST				$1,430,411

Alternative 3 (Soil)-- Capping With Pavement in Place
Option 2 (without wetlands sediment)

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
CAP INSPECTION	inspection	2	$2,000	$4,000	30	$49,636
CAP MAINTENANCE	sf	2900	$3	$7,714	30	$95,723
SUBTOTAL				$11,714		$145,360
CONTINGENCY (10% of Subtotal)				$2,929		$14,536
TOTAL				$14,643		$159,895

Alternative 3B (Wetland Sediment)-- Excavation, Regrading
With Biosolid Compost Material, Wetland Revegetation/Restoration

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION	each	1	$50,000	$50,000
EXCAVATION				
Sediment Excavation	cy	9,300	$10.00	$93,000
Dust Control and Placement with site soils)	cy	9,300	$10.00	$93,000
Excavation Monitoring	sample	20	$500.00	$10,000
WETLANDS RESTORATION/REVEGETATION				
Backfill Excavated Area with Biosolid Compost	acre	6	$20,000.00	$114,000
Plant Forested Wetland Area	acre	3	$3,500.00	$10,500
Plant Emergent Wetland Area	acre	9	$5,500.00	$49,500
Supplies	lump sum	1	$1,600.00	$1,600
Runon/runoff Control	ft	2,800	$0.78	$2,184
EQUIPMENT & MATERIALS				
Erosion Control	sy	500	$2.14	$1,070
Fencing	lf	2,800	$15	$42,700
Health & Safety Equipment	each	1	$80,000	$80,000
Subtotal - Capital Cost				$547,554
Engineering & Administrative (3% of Capital Cost)				$16,427
Subtotal				$563,981
Contingency (10% of Subtotal)				$56,398
TOTAL CONSTRUCTION COST				$620,379
PRESENT WORTH O&M COST				$79,170
TOTAL PRESENT WORTH COST				$699,548

Alternative 3B (Wetland Sediment)-- Excavation, Regrading
With Biosolid Compost Material, Wetland Revegetation/Restoration

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
WETLANDS INSPECTION	inspection	2	$2,000	$4,000	30	$49,636
WETLAND MAINTENANCE	acre	9	$200.00	$1,800	30	$22,336
SUBTOTAL				$5,800		$71,972
CONTINGENCY (10% of Subtotal)				$1,450		$7,197
TOTAL				$7,250		$79,170

Alternative 3 (Groundwater)-- Pump & Treat With Physical or Chemical Treatment - Scenario A Site Name: Ross Metals Site Location: Rossville, Tennessee			PRESENT WORTH COST Discount Rate: 7%	
ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION	lump sum	1	$60,000.00	$60,000
ADDITIONAL DATA COLLECTION				
Pump Test (Existing Wells)	lump sum	1	$25,000.00	$25,000
Determine Vertical Extent of GW Contamination	lump sum	1	$20,000.00	$20,000
TREATABILITY STUDY	lump sum	1	$20,000.00	$20,000
INSTALLATION OF 1 GW PUMPING WELL AND PUMP	well	1	$2,700.00	$2,700
TREATMENT SYSTEM				
System Housing	lump sum	1	$5,175.00	$5,175
Precipitation/Flocculation/Coaggulation &Sedimentation Sy	lump sum	1	$169,000.00	$169,000
Piping(influent/Effluent)-including trenching & backfill	lf	1,000	$5.65	$5,650
ELECTRIC UTILITIES	lump sum	1	$1,000.00	$1,000
Subtotal - Capital Cost				$308,525
Engineering & Administrative (3% of Capital Cost)				$9,256
Subtotal				$317,781
Contingency (10% of Subtotal)				$31,778
TOTAL CONSTRUCTION COST				$349,559
PRESENT WORTH O&M COST				$1,009,557
TOTAL PRESENT WORTH COST				$1,359,116

Alternative 3 (Groundwater)-- Pump & Treat With Physical or Chemical Treatment - Scenario A Site Name: Ross Metals Site Location: Rossville, Tennessee				OPERATION & MAINTENANCE COSTS Discount Rate: 7%		
ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
QUARTERLY GROUNDWATER MONITORING						
Personnel (2-man crew @ 2 12-hour days)	hours	192	$50	$9,600	12	$76,250
Supplies/ Travel	days	4	$3,000	$12,000	12	$95,312
Groundwater Sampling and Lab Testing	sample	36	$500	$18,000	12	$142,968
Report Preparation	lump sum	4	$4,000	$16,000	12	$127,083
TREATMENT SYSTEM OPERATION & MAINTENANCE						
Operation, disposal of solids	year	1	$42,700	$42,700	11	$320,193
System Inspections	inspection	52	$400	$20,800	11	$155,972
O&M SUBTOTAL				$119,100		$917,779
Contractor Fee (10% of O&M cost)				$11,910		$91,778
Legal Fees, Licenses & Permits (5% of O&M Cost)				$596		$4,589
CONTINGENCY (10% of Subtotal)				$29,775		$91,778
SUBTOTAL				$148,875		$1,009,557

Alternative 4 (Soil)-- Capping With Construction of Above Ground Disposal Cell
Option 2 (without wetland sediment)

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION				
	each	1	$80,000	$80,000
SITE DEMOLITION				
Building Demolition	cf	27,000	$0.23	$6,210
Concrete/Asphalt Demolition	sy	21,333	$10.37	$221,223
EXCAVATION				
Soil Excavation (Contaminated Soil)	cy	15,625	$5	$78,125
Dust Control	month	8	$3,500	$28,000
Excavation Monitoring	sample	20	$500	$10,000
CAPPING				
Spread/Compact Waste Soil and Debris	cy	26,325	$2.22	$58,442
Installation of Soil Cushion	cy	7,600	$2.22	$16,872
Installation of Geomembrane/Geotextile	sf	108,900	$1	$108,900
Installation of Common Fill Throughout Site	cy	16,150	$9.27	$149,711
Installation of Top Soil Throughout Site	cy	6,500	$19.90	$129,350
Installation of Vegetative Cover	acre	8	$2,000.00	$16,000
Runon/Runoff Control-Trenching	ft	2,500	$0.78	$1,950
Runon/Runoff Control-Sediment Trap	lump sum	1	$35,000.00	$35,000
EQUIPMENT & MATERIALS				
Erosion Control	sy	341	$2.14	$730
Fencing (Remove and Reset)	lf	2,100	$15	$32,025
Health & Safety Equipment	each	1	$120,000	$120,000
Subtotal - Capital Cost				$1,092,537
Engineering & Administrative (3% of Capital Cost)				$109,254
Subtotal				$1,201,791
Contingency (10% of Subtotal)				$120,179
TOTAL CONSTRUCTION COST				$1,321,970
PRESENT WORTH O&M COST				$159,895
TOTAL PRESENT WORTH COST				$1,481,865

Alternative 4 (Soil)-- Capping With Construction of Above Ground Disposal Cell
Option 2 (without wetland sediment)

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
CAP INSPECTION	inspection	2	$2,000	$4,000	30	$49,636
CAP MAINTENANCE	sf	2900	$2.66	$7,714	30	$95,723
SUBTOTAL				$11,714		$145,360
CONTINGENCY (10% of Subtotal)				$2,929		$14,536
TOTAL				$14,643		$159,895

Alternative 5 A(Soil)-- Excavation And Onsite Treatment With Solidification/Stabilization and Onsite Disposal
Option 1 (includes excavated wetland sediment)

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION				
	each	1	$80,000	$80,000
SITE DECONTAMINATION/DEMOLITION				
Building Demolition	cf	27,000	$0.23	$6,210
Concrete/Asphalt Demolition	sy	21,333	$10.37	$221,223
Building Decontamination	sf	126,000	$0.75	$94,500
Pavement Decontamination	sf	192,000	$0.85	$163,200
Equipment	lump sum	1	$25,000.00	$25,000
EXCAVATION				
Soil Excavation (Contaminated Soil)	cy	21,875	$5	$109,375
Soil Excavation (Onsite Disposal Area)	cy	40,000	$5	$200,000
Dust Control & Placement in Storage Areas	cy	61,875	$5	$309,375
Excavation of Landfilled Slag	cy	10,000	$2	$20,000
Excavation Monitoring	sample	25	$500	$12,500
ONSITE SOLIDIFICATION/STABILIZATION				
Treatability Study	lump sum	1	$50,000	$50,000
Treatment	ton	78,750	$30.00	$2,362,500
Treatment System Monitoring	sample	50	$500.00	$25,000
Spread/Compact Waste Soil and Debris	cy	52,771	$2.22	$117,152
Installation of Common Fill Throughout Site (from disposal	cy	42,000	$2.22	$93,240
Installation of Top Soil Throughout Site	cy	6,500	$19.90	$129,350
Installation of Vegetative Cover	acre	8	$2,000.00	$16,000
EQUIPMENT & MATERIALS				
Fencing (Remove and Reset)	lf	2,100	$15	$32,025
Health & Safety Equipment	each	1	$120,000	$120,000
Subtotal - Capital Cost				$4,186,650
Engineering & Administrative (3% of Capital Cost)				$125,599
Subtotal				$4,312,249
Contingency (10% of Subtotal)				$431,225
TOTAL CONSTRUCTION COST				$4,743,474
PRESENT WORTH O&M COST				$163,799
TOTAL PRESENT WORTH COST				$4,907,274

Alternative 5 A(Soil)-- Excavation And Onsite Treatment With Solidification/Stabilization and Onsite Disposal
Option 1 (includes excavated wetland sediment)

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
LAWN MAINTENANCE	month	12	$1,000	$12,000	30	$148,908
SUBTOTAL				$12,000		$148,908
CONTINGENCY (10% of Subtotal)				$3,000		$14,891
TOTAL				$15,000		$163,799

Assume a 20% increase in volume due to solidifcation/stabilization process

Alternative 5B (Soil)-- Excavation And Onsite Treatment With Solidification/Stabilization and Offsite Disposal
Option 1 (includes excavated wetland sediment)

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION				
	each	1	$80,000	$80,000
SITE DECONTAMINATION/DEMOLITION				
Building Demolition	cf	27,000	$0.23	$6,210
Concrete/Asphalt Demolition	sy	21,333	$10.37	$221,223
Building Decontamination	sf	126,000	$0.75	$94,500
Pavement Decontamination	sf	192,000	$0.85	$163,200
Equipment	lump sum	1	$25,000.00	$25,000
EXCAVATION				
Soil Excavation (Contaminated Soil)	cy	21,875	$5	$109,375
Dust Control & Placement in Storage Areas	cy	21,875	$5	$109,375
Excavation of Landfilled Slag	cy	10,000	$2	$20,000
Excavation Monitoring	sample	25	$500	$12,500
ONSITE SOLIDIFICATION/STABILIZATION				
Treatability Study	lump sum	1	$50,000	$50,000
Treatment	ton	78,750	$30.00	$2,362,500
Treament System Monitoring	sample	50	$500.00	$25,000
Offsite Disposal of Nonhazardous Material	ton	82,688	$30.00	$2,480,640
Installation of Common Fill Throughout Site	cy	39,800	$10.00	$398,000
Installation of Top Soil Throughout Site	cy	6,500	$19.90	$129,350
Installation of Vegetative Cover	acre	8	$2,000.00	$16,000
EQUIPMENT & MATERIALS				
Fencing (Remove and Reset)	lf	2,100	$15	$32,025
Health & Safety Equipment	each	1	$120,000	$120,000
Subtotal - Capital Cost				$6,454,898
Engineering & Administrative (3% of Capital Cost)				$193,647
Subtotal				$6,648,545
Contingency (10% of Subtotal)				$664,855
TOTAL CONSTRUCTION COST				$7,313,400
PRESENT WORTH O&M COST				$163,799
TOTAL PRESENT WORTH COST				$7,477,199

Alternative 5B (Soil)-- Excavation And Onsite Treatment With Solidification/Stabilization and Offsite Disposal
Option 1 (includes excavated wetland sediment)

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
LAWN MAINTENANCE	month	12	$1,000	$12,000	30	$148,908
SUBTOTAL				$12,000		$148,908
CONTINGENCY (10% of Subtotal)				$3,000		$14,891
TOTAL				$15,000		$163,799

Assume a 20% increase in volume due to solidifcation/stabilization process

Alternative 6A (Soil)-- Capping With Excavation and Onsite
Treatment and Disposal of Principal Threat Waste
Option 1 (includes excavated wetland sediment)

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION				
	each	1	$80,000	$80,000
SITE DEMOLITION				
Building Demolition	cf	27,000	$0.23	$6,210
EXCAVATION				
Soil Excavation (Contaminated Soil)	cy	7,000	$5	$35,000
Dust Control & Placement in Storage Areas	cy	7,000	$5	$35,000
Excavation of Landfilled Slag	cy	10,000	$2	$20,000
Excavation Monitoring	sample	10	$500	$5,000
ONSITE SOLIDIFICATION/STABILIZATION				
Treatbility Study	lump sum	1	$50,000	$50,000
Treatment	ton	45,000	$30	$1,350,000
Treatment System Monitoring	sample	12	$500	$6,000
CAPPING				
Spread/Compact Waste Soil and Debris	cy	37,240	$2.22	$82,673
Installation of Soil Cushion	cy	20,300	$10.00	$203,000
Installation of Geomembrane/Geotextile	sf	291,852	$1	$291,852
Installation of Common Fill Throughout Site	cy	16,150	$10.00	$161,500
Installation of Top Soil Throughout Site	cy	6,500	$19.90	$129,350
Installation of Vegetative Cover	acre	8	$2,000.00	$16,000
Runon/Runoff Control-Trenching	ft	2,500	$0.78	$1,950
Runon/Runoff Control-Sediment Trap	lump sum	1	$35,000.00	$35,000
EQUIPMENT & MATERIALS				
Erosion Control	sy	341	$2.14	$730
Fencing (Remove and Reset)	lf	2,100	$15	$32,025
Health & Safety Equipment	each	1	$120,000	$120,000
Subtotal - Capital Cost				$2,661,290
Engineering & Administrative (3% of Capital Cost)				$79,839
Subtotal				$2,741,128
Contingency (10% of Subtotal)				$274,113
TOTAL CONSTRUCTION COST				$3,015,241
PRESENT WORTH O&M COST				$159,895
TOTAL PRESENT WORTH COST				$3,175,137

Alternative 6A (Soil)-- Capping With Excavation and Onsite
Treatment and Disposal of Principal Threat Waste
Option 1 (includes excavated wetland sediment)

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
CAP INSPECTION	inspection	2	$2,000	$4,000	30	$49,636
CAP MAINTENANCE	sf	2900	$3	$7,714	30	$95,723
SUBTOTAL				$11,714		$145,360
CONTINGENCY (10% of Subtotal)				$2,929		$14,536
TOTAL				$14,643		$159,895

Alternative 6B (Soil)-- Capping With Excavation and Onsite
Treatment /Offsite Disposal of Principal Threat Waste
Option 1 (includes excavated wetlands sediment)

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION				
	each	1	$80,000	$80,000
SITE DEMOLITION				
Building Demolition	cf	27,000	$0.23	$6,210
EXCAVATION				
Soil Excavation (Contaminated Soil)	cy	7,000	$5	$35,000
Dust Control & Placement in Storage Areas	cy	7,000	$5	$35,000
Excavation of Landfilled Slag	cy	10,000	$2	$20,000
Excavation Monitoring	sample	10	$500	$5,000
ONSITE SOLIDIFICATION/STABILIZATION				
Treatbility Study	lump sum	1	$50,000	$50,000
Treatment	ton	45,000	$30	$1,350,000
Treatment System Monitoring	sample	12	$500	$6,000
Offsite Disposal of Treated nonhazardous principal threat wast	ton	54,000	$30	$1,620,000
CAPPING				
Spread/Compact Waste Soil and Debris	cy	7,600	$2.22	$16,872
Installation of Soil Cushion	cy	20,300	$10.00	$203,000
Installation of Geomembrane/Geotextile	sf	291,852	$1	$291,852
Installation of Common Fill Throughout Site	cy	16,150	$10.00	$161,500
Installation of Top Soil Throughout Site	cy	6,500	$19.90	$129,350
Installation of Vegetative Cover	acre	8	$2,000.00	$16,000
Runon/Runoff Control-Trenching	ft	2,500	$0.78	$1,950
Runon/Runoff Control-Sediment Trap	lump sum	1	$35,000.00	$35,000
EQUIPMENT & MATERIALS				
Erosion Control	sy	341	$2.14	$730
Fencing (Remove and Reset)	lf	2,100	$15	$32,025
Health & Safety Equipment	each	1	$120,000	$120,000
Subtotal - Capital Cost				$4,215,489
Engineering & Administrative (3% of Capital Cost)				$126,465
Subtotal				$4,341,953
Contingency (10% of Subtotal)				$434,195
TOTAL CONSTRUCTION COST				$4,776,149
PRESENT WORTH O&M COST				$159,895
TOTAL PRESENT WORTH COST				$4,936,044

Alternative 6B (Soil)-- Capping With Excavation and Onsite
Treatment /Offsite Disposal of Principal Threat Waste
Option 1 (includes excavated wetlands sediment)

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Ross Metals Site
Site Location: Rossville, Tennessee

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
CAP INSPECTION	inspection	2	$2,000	$4,000	30	$49,636
CAP MAINTENANCE	sf	2900	$3	$7,714	30	$95,723
SUBTOTAL				$11,714		$145,360
CONTINGENCY (10% of Subtotal)				$2,929		$14,536
TOTAL				$14,643		$159,895